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ElectronicsWeek®

THE MAGAZINE OF THE WORLDWIDE ELECTRONICS INDUSTRY

2 APR [illegible]

DEALING WITH TOXIC CHEMICALS

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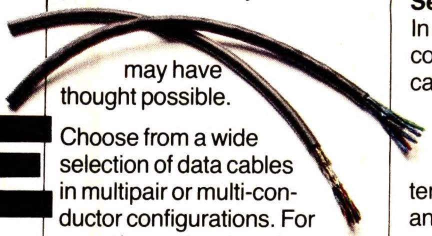
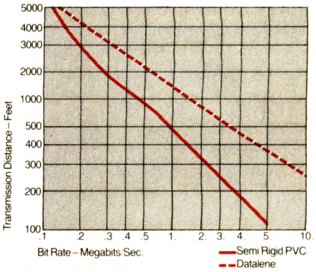
When data speed and distance set the limits to superior performance of your computer system, your design requires a new cable solution. Belden's new Extended Distance Data Cables provide faster data rates over longer distances while maintaining the integrity of the signal. This new series of data cables combines Belden's unique Datalene® foam dielectric or semi-rigid PVC insulation with superior shielding technology to achieve higher levels of performance than you may have thought possible.



Choose from a wide selection of data cables in multipair or multi-conductor configurations. For capacitance levels as low as 12.5 pF/ft., specify Datalene insulation, available in conductor sizes of 24 and 28 AWG. Or request semi-rigid PVC insulation, offered in conductor sizes of 22, 24 or 28 AWG. All cables are shielded with foil and 65% braid for superior shielding effectiveness at both low and high frequencies. 24 AWG multipair cables are also available with individual pairs shielded in foil, plus an overall foil/braid shield for critical high noise applications.

Bit rate vs. distance for individually shielded single pair cables.



Charts assume 5% peak to peak time jitter as determined by eye pattern measurements of pseudorandom NRZ code.

Let Belden assist you with the selection of data cables to suit your system needs at the onset of your design. This may help you avoid the need for costly overdesigned cable later on.

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International edition

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Next ElectronicsWeek

Computers are changing the nature of the factory

The old factory floor is no longer what it used to be. The arrival of computer-integrated manufacturing is forcing old concepts of management and manufacturing to do a flip-flop. The foreman no longer makes all the rules. And no longer are engineering, design, testing, parts procurement, tool allocation, scheduling, labor use, and shipping controlled by different departments, to come together only in the final product. The reason is that computer control has merged three concepts: first, it really is electronically integrated manufacturing; second, it involves a distribution of hierarchies; and third, it collects, controls, processes, and disseminates data. Collect all the details in next week's issue of *ElectronicsWeek.*

How to select an IC tester

Nothing can cause as much heated discussion among staff members of an engineering group as whether to test components at incoming inspection. The question pits one group of engineers and managers against another because neither the criteria for evaluation nor the reasons to test are clear and undisputed. And even when all agree that incoming test is necessary, another round of discussions is needed to pick the equipment. See next week's *ElectronicsWeek* for a guide.

Looking ahead in ElectronicsWeek

Toxic-waste and work-safety problems: part 2

The first of two articles on the threats posed by the toxic chemicals that are used in electronics manufacturing, dealing mostly with Silicon Valley, appears on p. 32. Next week, in the second part of this exclusive story, *ElectronicsWeek*'s editors report on the situation around the world.

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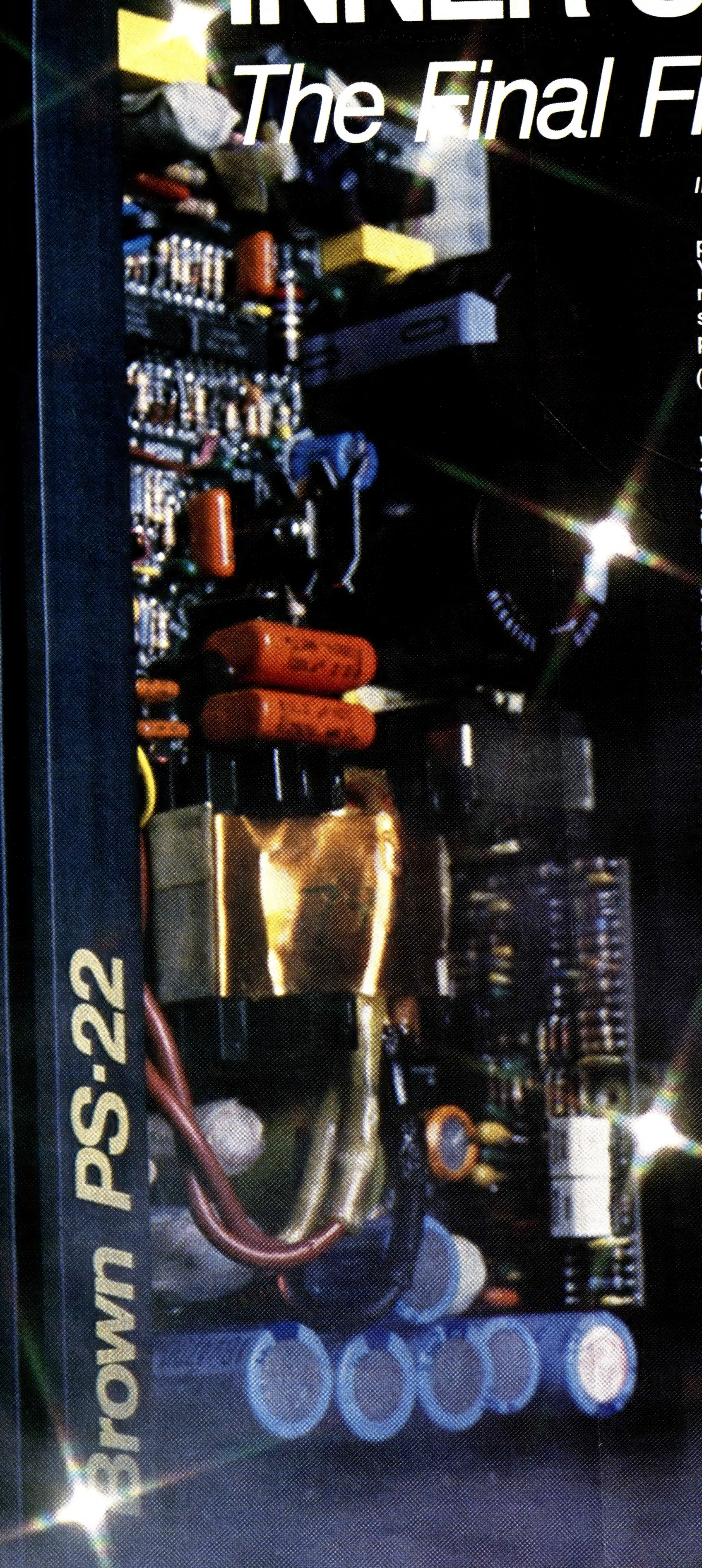

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ElectronicsWeek

THE VOICE OF THE INDUSTRY, HEARD EVERY MONDAY

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Investigative Report: Manufacturing

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For AMD, the cost is compounded Steeply rising insurance costs are bad enough. Now some carriers are balking at paying out claims for spills **34**

When alarm sounds, chemists roll Santa Clara fire department forms chemical division to deal with toxic materials **36**

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Solid state RF amplifier for NMR delivers 1000 W from 0.3 to 35 MHz.

ENI announces another breakthrough in RF power amplifier technology. At last there is a commercially available solid state amplifier offering a CW or pulse output of 1000 Watts from 0.3 to 35 MHz.

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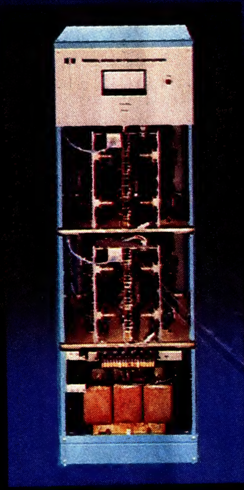

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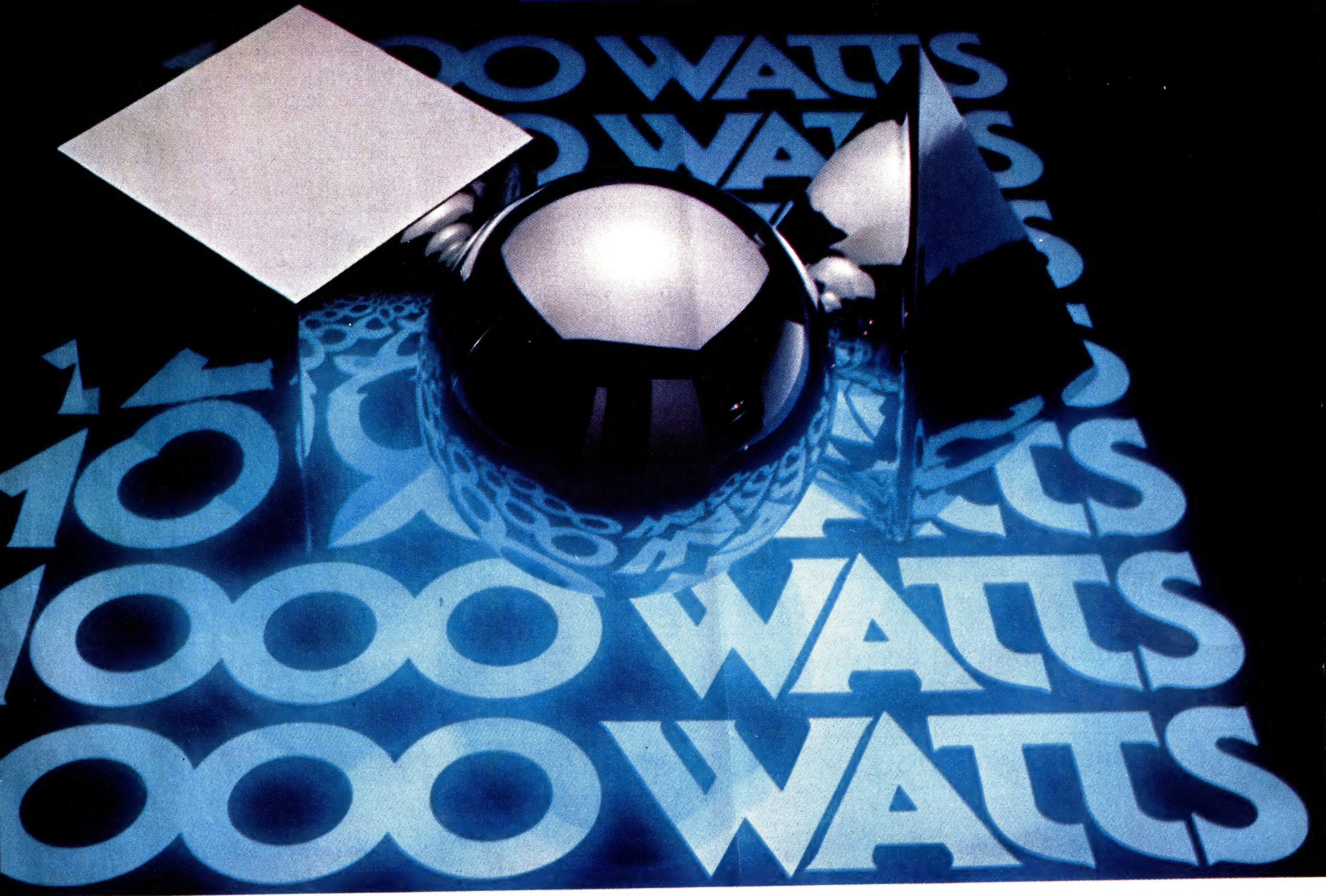

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1985 Hanover Fair, Association of German Plant and Machine Manufacturers (Amt für Verkehrsförderung, Friedrichswall 5, D-3000, Hanover 1, West Germany), Fair Grounds, Hanover, April 17-24.

Symposium on Lasers and Particle Beams for Fusion and Strategic Defense, University of Rochester *et al.* (Stephen Braun, Office of Public Relations, University of Rochester, Rochester, N.Y. 14627), University of Rochester and Rochester Plaza Hotel, Rochester, April 18-19.

In-Stat Semiconductor Forum: A Perspective on the Future, In-Stat Inc. (P.O. Box 8130, Scottsdale, Ariz. 85252), The Pointe at Tapatio Cliffs, Phoenix, Ariz., April 28-30.

Association for the Advancement of Medical Instrumentation Annual Meeting, AAMI (1901 N. Fort Myer Dr., Suite 602, Arlington, Va. 22209), Boston Marriott Copley Place, Boston, May 4-8.

1985 International Tool & Manufacturing Engineering Conference and Exposition, Society of Manufacturing Engineers (1 SME Dr., Dearborn, Mich. 48121), Cobo Hall, Detroit, May 6-9.

Radcure '85, Society of Manufacturing Engineers (AFP/SME Public Relations, 1 SME Dr., Dearborn, Mich. 48121), Basel, Switzerland, May 6-8.

ECIO '85—Third European Conference on Integrated Optics, Deutsche Gesellschaft fur Angewandte Optik, *et al.* (ECIO '85, I. Weber-Zuckarelli, Heinrich-Hertz-Institut Berlin GmbH, Bereich Integrierte Optik, Einsteinufer 37, D-1000 Berlin 10), Berlin, May 6-8.

Comdex/Spring '85, The Interface Group (300 First Ave., Needham, Mass. 02194) Georgia World Congress Center, Atlanta, May 6-9.

1985 Canadian High Technology Show, Canadex Productions (2487 Kaladar Ave., Suite 214, Ottawa, Ont., Canada), Ottawa Civic Centre, Ottawa, May 7-8.

Topical Conference on Basic Properties of Optical Materials, National Bureau of Standards (A. Feldman, B348 Materials Building, NBS, Gaithersburg, Md. 20899), NBS, Gaithersburg, May 7-9.

International Power Machinery and Technology Show, American Exhibition Services International Inc. (P.O. Box 66373, O'Hare International Airport, Chicago, Ill. 60666), Beijing, People's Republic of China, May 7-12.

Memory Card Technology, Battelle Memorial Institute (Phil Wells, Battelle Memorial Institute, Columbus Division, 505 King Ave., Columbus, Ohio 43201-2693), San Francisco Crowne Plaza, San Francisco, May 8-9.

ISDN/Future Networks '85, Information Gatekeepers Inc. (Joan Barry, Information Gatekeepers Inc., 214 Harvard Ave., Boston, Mass. 02134), Claridge Hotel and Casino, Atlantic City, N.J., May 8-10.

Second International Symposium on VLSI Technology, Systems, and Applications, National Science Council, Republic of China *et al.* (J.H. Tseng, ERSO, ITRI, P.O. Box 150, Hsinchu, Taiwan 300, Republic of China) Lai Lai Sheraton Hotel, Taipei, Taiwan, May 8-10.

Seminars

Advanced Avionics Integration, Technology Transfer Society (Technology Training Corp., Department AAI, P.O. Box 3608, Torrance, Calif. 90510-3608), Sheraton National Hotel, Washington, May 6-7.

Database: A Builder's Guide, Technology Transfer Institute (741 Tenth St., Santa Monica, Calif. 90402), Marriott, Los Angeles, May 6-9.

Ada Software Engineering Workshop, Technology Transfer Institute (741 Tenth St., Santa Monica, Calif. 90402), Four Seasons Olympic Hotel, Seattle, April 29-May 3; Copley Plaza, Boston, May 6-10.

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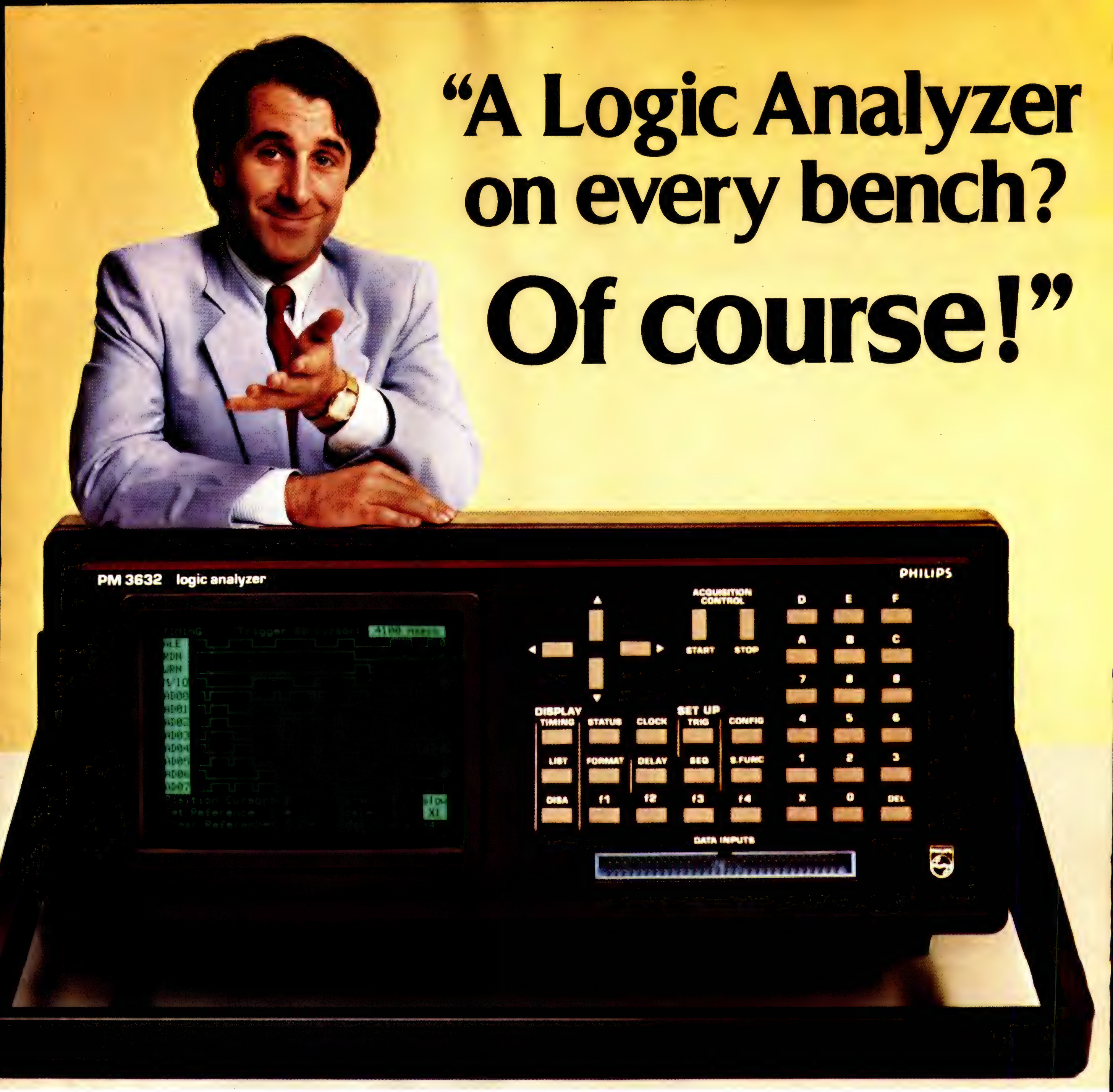

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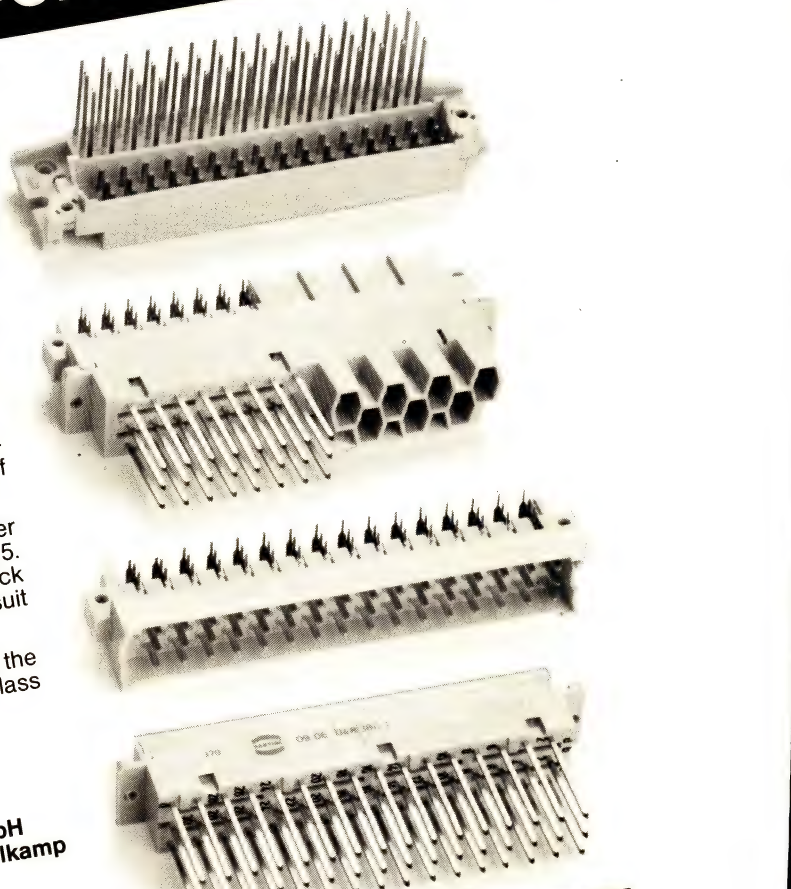

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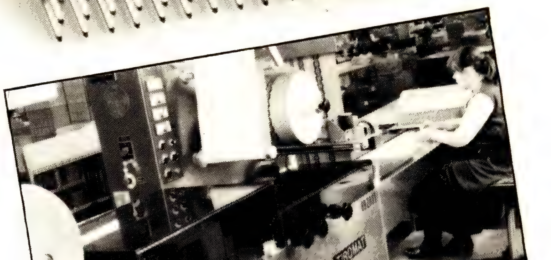

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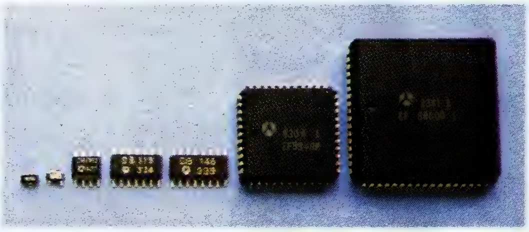
- *Display controllers.*
- *Gate arrays.*

Most of these products are also available in ceramic chip carriers.



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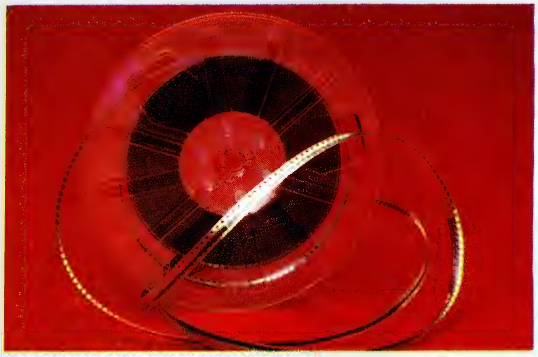

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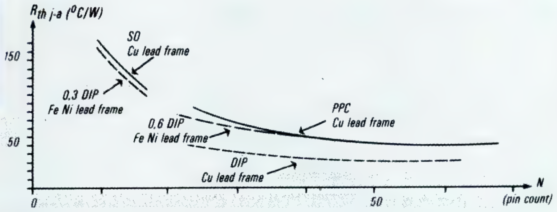

Junction-ambient air thermal resistance, components reported on classical PC board (FR 4, 1.3 mm thickness, 50 x 50 mm size).

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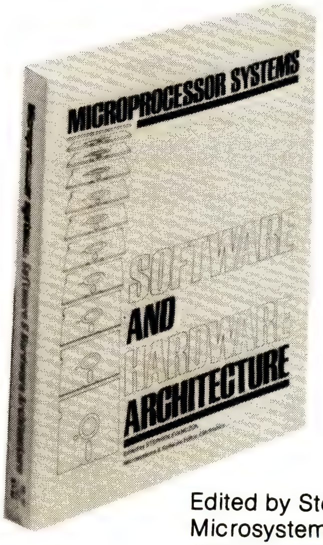

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SINCLAIR PLANS WAFER-SCALE FIRM

Britain's Sir Clive Sinclair will seek $54 million within the next few months to fund a new firm that will make wafer-scale integrated circuits. It will be headed by Robb Wilmot, chairman of International Computers Limited plc and formerly managing director of Texas Instruments (UK) Ltd. Wilmot, who will retain his job at ICL, will be responsible for attracting venture capital, recruiting senior management, and planning manufacturing.

One possibility being considered by Sinclair is to have Ferranti Semiconductors, a major supplier of Sinclair Research Ltd.'s custom chips, also provide technical support to the new venture. Although Sinclair Research has developed a process for making wafer-scale ICs, there are similarities between the two firms' technologies. And both companies believe that low-power bipolar processes will have the edge on CMOS technology as circuit densities increase.

The startup's plans call for both wafer-scale memories and fifth-generation, non-von-Neumann computers to be integrated onto a wafer. The firm will exploit research done at Sinclair's Metalab laboratories. Sinclair is due to launch a 0.5-megabyte solid-state disk-storage replacement, based on a wafer-scale circuit, in late 1985 or early 1986 [*ElectronicsWeek,* Feb. 25, 1985, p. 21]. It will be integrated with the company's flat-screen monitor for use in a new Z80-based portable computer, sources say. But to get this product to market quickly, Sinclair will use Japanese-made n-MOS wafers rather than its new bipolar process.

Sinclair is pressing ahead with these plans despite the rocky state of the personal computer market, which has dented its profits. After a provision of $8.1 million, Sinclair Research posted a pretax profit of $8.53 million on sales of $96.7 million in the nine-month period that ended December 1984. Sales for the full year are expected to be close to $108 million. ☐

Startup produces 16-bit CMOS version of bipolar 2901 microprocessor

Waferscale Integration Inc., the Fremont, Calif., startup that last fall put the bipolar 2901 microprocessor into a CMOS standard cell [*ElectronicsWeek,* Dec. 3, 1984, p. 22], has now released a 16-bit version of the chip. The circuit has four 2901 cells and a 2902-equivalent carry/look-ahead unit. It can be cascaded to produce a 32-bit CMOS microprocessor with the speed of the bipolar version. The chip operates at a 15-MHz clock rate and has a maximum propagation delay from the clock to the output of 70 ns. It consumes 150 mW versus more than 4 W for the bipolar version. ☐

February's book-to-bill ratio creeps up as cancellations slow, orders rise

The Semiconductor Industry Association's preliminary data indicates that the semiconductor industry's book-to-bill ratio increased to 0.79:1 in February from January's 0.66:1. The average monthly orders for the three-month period ending in February totaled $666.9 million, up 11% from January. Bookings for February were $744.4 million. The SIA attributed the slight rise to increasing demand from original-equipment manufacturers and distributors and to a slowing in order cancellations. ☐

UP FRONT

Chip industry's woes force slowdown at National Semiconductor

Despite the book-to-bill improvement, the semiconductor industry's woes continue. A plant retooling at National Semiconductor Corp. will cause the layoff of 400 workers in Salt Lake City, Utah. The firm reports, however, that instead of the proposed two-week shutdown in April, it has instituted a four-day work week that will continue for the next 10 weeks. ☐

NEC researchers develop world's shortest-wavelength laser

A research team at NEC Corp.'s Opto-Electronic Research Labs and Fundamental Research Labs has developed the world's shortest-wavelength room-temperature semiconductor laser for continuous-wave operation, at 671 nm. The Kawasaki firm fabricated the experimental double-heterojunction laser by vapor-phase epitaxy in a proprietary dual-growth-chamber reactor. The indium-gallium phosphide double heterojunction is grown on a gallium arsenide phosphide substrate. A representative says the team should soon be able to develop a replacement for the 630-nm helium-neon-gas lasers widely used as a light source in optical information-processing systems. The advantages of the shorter wavelength include lower loss in optical fibers, higher sensitivity of drums in printers, greater visibility, and higher resolution. ☐

Toshiba in talks to market AT&T gear in Japan

Toshiba Corp. is talking with AT&T Co. about a deal to aid in marketing the U.S. firm's switches and terminals in Japan. The electronic switches, which are suitable for both public communications networks and private branch exchanges, would be sold to competitors of Nippon Telegraph & Telephone Public Corp., value-added networks, and large firms. NTT is being privatized on April 1, and competition will be allowed (see story, p. 26). ☐

Exel Microelectronics, Oki Electric in pact to make EEPROMs

Exel Microelectronics Inc. last week said it was entering into a cooperative agreement with Oki Electric Industry Co., under which Oki will second-source Exel's 16-K electrically erasable programmable read-only memory chip. According to Exel, Oki will start mass-producing and selling the chips later this month. The Japanese firm plans to start producing a 64-K EEPROM this summer. Exel says it has been shipping its 16-K EEPROM—the MSM2816A—in volume since last November. ☐

IBM managerial shuffle brings Estridge to New York

In a corporate shuffle, Philip D. Estridge, president since 1980 of IBM Corp.'s $4.5 billion Entry Systems Division in Boca Raton, Fla., will move to corporate headquarters and head the firm's worldwide manufacturing activities. William C. Lowe, most recently assistant group executive of the Information Systems and Communications Group, will succeed Estridge. The moves come on the heels of an earlier announcement that Jack D. Kuehler, then head of IBM's semiconductor and mainframe computer operations, was to take charge of overall new-product development and efforts to improve manufacturing. Replacing Kuehler will be John E. Bertram, in charge of the chip development and packaging group, and Carl J. Conti, who will direct development of high-end mainframes and disk drives. ☐

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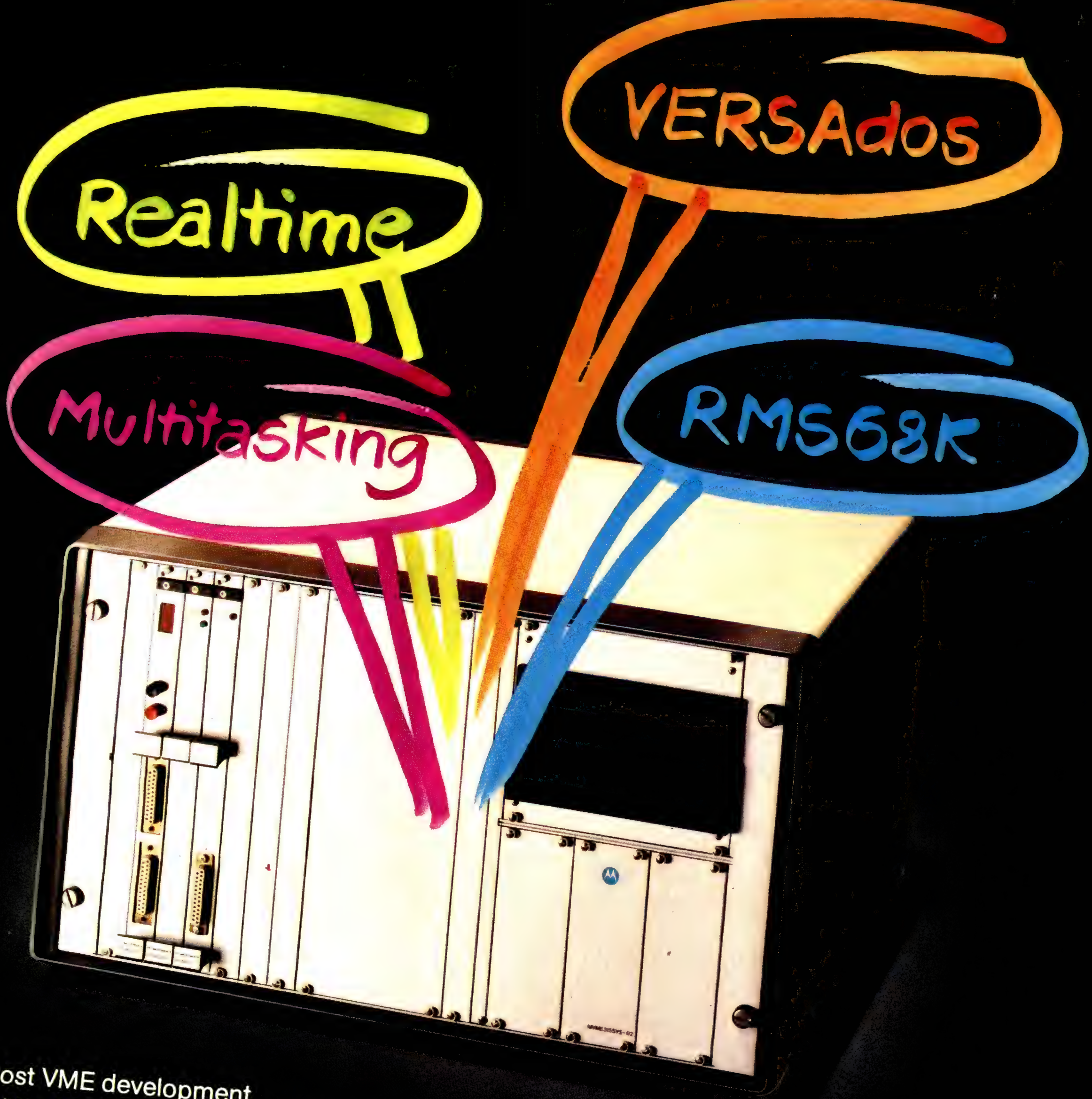

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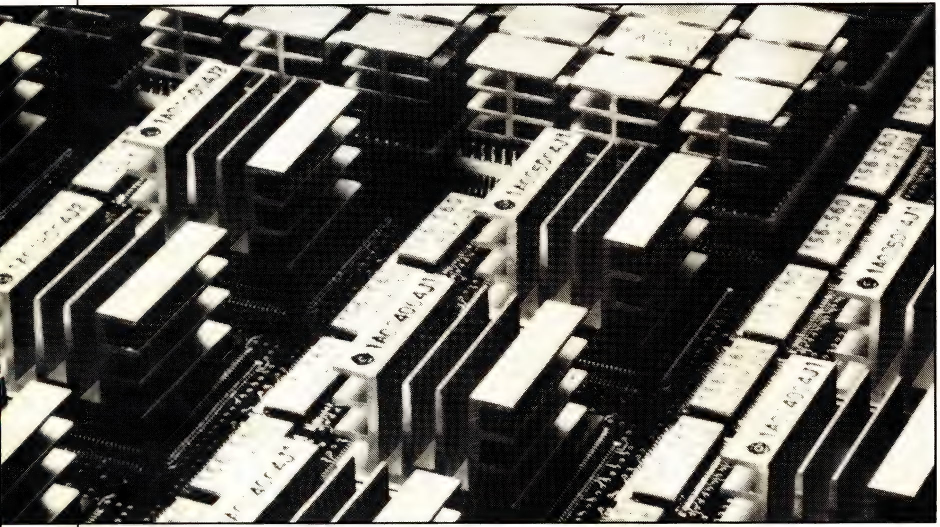
AROUND THE WORLD

HITACHI CPU CHALLENGES IBM

Tokyo firm aims to be first to market with mainframes it says are cheaper, smaller, and just as fast as Big Blue's new entries

☐ *by Charles L. Cohen*



All aboard. Processor circuit boards in Hitachi's new family of mainframe computers carry both ultrahigh-speed memory modules (rear) and very-high-speed ECL gate arrays.

Tokyo

Yet another attempt to take turf away from IBM Corp. in the computer market was launched last week as Hitachi Ltd. brought forth its latest mainframe entries.

Hitachi is basing its foray on top-of-the-line machines it maintains are "equal or superior in performance" to IBM's latest offerings. The Hitachi uniprocessor M-680H outdoes IBM's new dyadic 3090/200 model, a company executive boasts. Its M-682H dyadic processor system, he adds, will match IBM's four-processor 3090/400 in performance. Yet it will take half as much floor space, list for about 5% less, and come to market more than a year earlier.

The Hitachi move follows by only a week NEC Corp.'s introduction of a high-powered family of non-IBM-compatible mainframes [*ElectronicsWeek,* March 11, 1985, p. 16]. Hitachi's new family, however, takes direct aim at IBM's new 3090 family as well as other IBM-compatibles such as Fujitsu Ltd.'s three-year-old M-380 model group in Japan and Amdahl Corp. machines in the U.S.

Broad attack. Hitachi plans to press its attack in both the U.S. and Europe. Simultaneous with Hitachi's announcement, National Semiconductor Corp.'s National Advanced Systems unit in the U.S. and the BASF Group in West Germany brought out their versions of the systems. Hitachi's other selling partner, Ing. C. Olivetti & C. SpA, Italy, will announce later. This is the first time that National and BASF have announced at the same time as Hitachi; in the past, they have lagged behind by about six months.

According to National, the single-processor M-680H, called the AS/XL model 60, is rated at 30 million instructions per second, the same as IBM's 3090/200. The two-processor M-682H (National's AS/XL model 80) is rated at 50 mips, the same as the 3090/400.

First shipments of both Hitachi models are scheduled for the fourth quarter of 1985. (IBM's 3090/200 is due in November, while the 3090/400 will be available in the second quarter of 1987.) Export versions sold by National, BASF, and Olivetti are expected to be shipped in the second quarter of next year. Hitachi expects to sell about 300 systems in Japan during the next four years and probably the same number overseas, primarily through National Advanced Systems.

In the U.S., National is quoting its list price for the AS/XL model 60 at $4.8 million, and $8.9 million for the model 80. These are both configured with 32 input/output channels and 64 Mb of main memory. IBM's 3090 model 200 is priced at $5 million. The 400, available only as an upgrade to the model 200, costs another $4.3 million.

Leading edge. To get to market with machines having specifications a notch higher than IBM's, Hitachi turned to leading-edge technology. For example, the high-speed logic portions of Hitachi's computer are implemented in emitter-coupled-logic gate arrays carrying either 2,000 or 5,000 gates. The logic in IBM's 3090, by contrast, is based on 612-gate ECL chips. What's more, this is IBM's first use of ECL in its mainframes. Hitachi used ECL for a number of earlier models.

The Hitachi arrays with 2,000 gates have a propagation delay time of 200 ps; those with 5,000 gates have a delay of 250 ps. Both types have minimum feature sizes of 1.5 μm and V-groove isolation for reduced parasitic capacitance. The 2,000-gate chips measure 6.8 mm on a side, the 5,000-gate arrays 9.3 mm.

Logic circuits in the Hitachi system operate from a –3-V power supply for reduced dissipation. Even so, they consume 6 W each. The memory chips operate from industry-standard –5.2-V supplies. But the 1-K chips dissipate only 1 W; the 4-K chips dissipate 0.85 W.

Cool logic. To help keep temperatures of logic chips low enough for air cooling, they are sealed in silicon carbide flat packs that have leads with 20-mil spacing on four sides. Packing density can be much higher than with pin-grid or other configurations because no holes through the printed-circuit board are required. Leads are soldered to the top layer of the 20-layer epoxy pc boards, and via holes make connections to the appropriate internal layer.

Up to 72 logic chips or cache-memory hybrid parts are mounted on each 280-by-400-mm board. Also contributing to system performance are 40,000-gate custom CMOS integrated circuits for channel control, implemented in 1.3-μm design rules on a chip 11.4 mm on a side.

Like Fujitsu's and NEC's large computers, Hitachi's new machines use a three-level memory hierarchy, with Hitachi opting for larger cache memories than its competitors. Processor cache is 256-K bytes, compared with the 64-K bytes used by Fujitsu and 128-K bytes used by NEC. The work-storage cache is 1 megabyte, while Fujitsu's equivalent global cache is 256-K and NEC's system cache is 512-K. Maximum main-memory size is 256 megabytes, the same as NEC's new ACOS 1540, and twice that of the 3090/200. ☐

Additional reporting was provided by Tom Manuel in New York.

TELECOMMUNICATIONS

NEW DIGITAL PBX SYSTEM RIDES EXPANDABLE BUS

Dallas

A telecommunications startup here has begun shipping a small digital private-branch-exchange system which, unlike larger voice/data PBX products, does not need a phone-line switching matrix.

Working with a system architecture similar to one used in personal computers, SRX Inc. has replaced the conventional switching matrix of PBXs with custom integrated circuits and a fast, expandable 8-bit bus for voice/data communications. When an office phone system must be expanded, 12-port digital line cards can be attached to the 32-Mb/s, byte-wide bus. With this feature, users can incrementally expand the phone-line switching of the new digital PBX.

Aimed at offices that need 6 to 255 stations, the new PBX, based on the 8088 microprocessor, will carry the same price as small and medium-sized analog voice-only systems, the company says. Each station will cost from $700 to $750 per user.

By competing on an equal price footing with older analog systems, SRX expects huge sales in what it believes is a relatively untapped market for small digital voice/data PBXs. The firm's backers look for small-to-medium-sized digital systems to become the fastest growth segment of a total market now reaching sales of $4 billion annually.

Radical departure. SRX's modular approach to the overhead of switching hardware represents a radical departure from matrix-based systems, says Charles B. Johnson, president and cofounder of the 17-month-old firm. The problem with switching matrixes of conventional PBX designs is that all the electronic hardware needed to handle the maximum number of users must already be in an entry-level system, he says. He adds that those overhead costs have made it difficult for emerging digital PBXs to compete with small analog voice-only systems, which are based on an older and often lower-cost technology.

At the heart of the PBX, in a 16-by-12-by-12-in. cabinet, is a Resource Controller Board similar to the backplane central processing boards of many personal computers. This board contains the 32-Mb/s communications bus, digital-line expansion slots, an 8088-based call processor, a separate 8-bit processor bus, and embedded software to change the characteristics of a system as it grows—from fewer than 20 users up to 255.

Hopeful. SRX head Charles B. Johnson sees big sales in the new market for small voice/data PBXs.

Custom CMOS circuits reside on SRX's 12-port digital instrument cards, so that the 32-Mb/s bus can act as a switching vehicle. Each very large-scale IC can handle six digital lines. Each digital instrument card has two of the bus-interface chips. In addition, the custom VLSI circuits are used on three-port analog trunk cards, which connect the public network to the digital PBX.

The SRX network can transmit asynchronous data at 19.2 kb/s and synchronous data at 64 kb/s. A total of 288 ports or channels can be used for voice or data connections. Johnson says the SRX PBX takes up about half the space of more conventional designs. – **J. Robert Lineback**

SINKING THE PROGRAM PIRATES

With big bucks in lost sales at stake, manufacturers have banded together to develop protection-hardware standards

☐ *by Denise Caruso*

Palo Alto

Until recently, protecting disk-resident software was a problem without answers. When the Association of Data Processing Service Organizations announced in January that it was developing a hardware barrier to software piracy, microcomputer firms that sell software—many of them already investing staff and lab space in the same project—took a deep breath in the hope that the proposal would catch on. Adapso's figures show that the industry may have lost $325 million last year from illegal disk copying.

Although taking a hardware approach is not new, what is unusual about the Adapso project is that so many competitors are working on it together. Ashton-Tate, Digital Equipment, Hewlett-Packard, Lotus, Microsoft, Micropro International, and many other companies that compete in the cutthroat microcomputer-software market are putting their heads together as members of the Adapso Software Protection Committee to outmaneuver software pirates.

The entire process has been an open book. "We're creating not a product but standards around which products will be built," says Marvin Goldschmitt, vice president of business development for Lotus Development Corp. and chairman of the Adapso committee. He says the committee will sponsor all-day seminars in April on both coasts for the technical staffs of software companies "to get them up to speed and get their input" on standards.

May vote. Then in May, Adapso members will vote on a formal document that proposes the agreed-on standards during a three-month period. "I'd much rather people screamed before than after the decisions are made," says Goldschmitt. He says the proposal's major issue is developing communications protocols that will make protection tools as interchangeable as the myriad of telephones now on the market.

In its simplest implementation, the Adapso proposal revolves around the development of what is being called a key ring. The product, a pass-through connector about the size of a cigarette pack, probably containing a microprocessor and a read-only-memory chip, will plug into a microcomputer's RS-232-C port.

When a program disk is first booted, the key ring will encrypt it with a code that allows the software to run only when the key ring is present. If the standardization process works as expected, any key will fit any key ring and run anything that hooks up to an RS-232-C port.

No protection. Seymour I. Rubinstein of Micropro claims that sales of WordStar 2000 have increased since the company publicized its decision to remove its finicky disk-based protection.

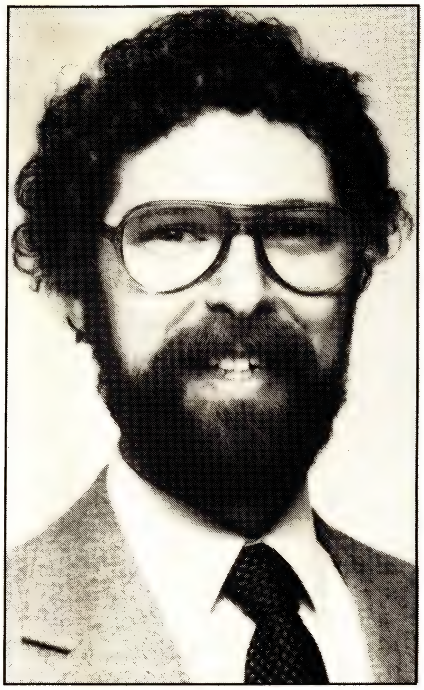
To promote its presence in the industry, Goldschmitt says, this first no-frills device will probably be distributed at no charge when a customer buys a software package. But more sophisticated implementations will probably have to be purchased by users because they will be much more expensive to produce. These more complex versions might use either optional keys that plug into the key ring or various levels of access codes for different parts of the software. In fact, many participating software houses are talking about company-specific keys that could be activated electronically after a user purchases software.

Big change. Undoubtedly, the Adapso device would change the way the software industry does business. "In terms of the old cliche, software will become the razor and the keys will become the razor blade," says Goldschmitt. "Software might be available for free, but you won't be able to use it unless you have the authorization device in residence and pay for the rights to use the software, as opposed to simply buying the product."

It will also correct many of the problems of disk-resident-software protection schemes, because users will be able to make as many copies of their software as they like. Also, the keys will work on both hard disks and, with some adaptation, on local-area networks. And because the Adapso design calls for the key rings to be transportable from one computer to another, the problem of moving software among machines would also be solved.

One company, Micropro International Corp., thinks the key ring may open up another market. "It will finally make electronic distribution of software a feasibility," says Micropro's founder and chairman emeritus, Seymour I. Rubinstein. "Someone could download a program from an on-line information service, call an 800 number, and use a charge card to buy a code number that actuates the install procedure for that particular software."

Toward these goals, Digital Equipment Corp. is working on a prototype that conforms to Adapso transport protocols for the proposed RS-232-C interface. Barry Folsom, former head of Digital's Rainbow personal computer division, is now vice president of East Coast engineering for Sun Microsystems Inc. Before leaving Digital, Folsom said in an interview that by getting an Adapso prototype running, he hoped to perfect a standard with which everyone could comply.



Forewarned. "I'd rather people screamed before than after decisions are made," says Adapso chairman Marvin Goldschmitt.

"This solution is the most workable one, at least in the short term, because most microcomputers have an RS-232 port, whether it's standard or optional," he says. Although Digital is just getting started on the prototype, Folsom believes the company will finish a working model within four months.

Hewlett-Packard Co. is also working with Adapso. Paul Maybaum, the product marketing manager who pulls together all software-security efforts for the company, says Adapso's technical information is being reviewed by many HP divisions.

HP has been using a similar, though not RS-232-based, device for two years now. Called the EGS200 Security Mechanism (because it was first used on a computer-aided-design package called the EGS200), it uses a programmable ROM on the processor board to identify users. Maybaum says the method poses some transportability problems, but "our thinking here doesn't take us toward RS-232, even though it has the advantage of being universally available. Adapso's whole definition revolves around interacting with the key ring. We feel that eventually the key ring would be built in, and all the user would see is that you'd plug in the keys."

Keeping users out of the process while still protecting their programs is a situation with which all companies who use disk-based protection have had to contend. Some have met with limited success. Micropro, for example, made a surprise announcement in February that it was removing all copy protection from its newest word-processing program, WordStar 2000, because customers complained it made the program difficult to use.

Fait accompli. Removing the copy protection is a shocking action for Micropro, which lost millions of dollars in revenue from its original WordStar, probably the most pirated program in the industry.

But the industry needs more than the copy-protection schemes now in use. "Customers are getting more angry with us because they're being inconvenienced by the current [antipirating] technology," observes Goldschmitt. "And what's worse, the illegitimate customers have defeated the protection already."

Elliot Goldyn, director of integrated product development at Ashton-Tate Corp., claims two major problems are inherent in a hardware protection device. "From a software manufacturer's standpoint, it's difficult to get people interested in [changing the packaging process and] sending off a piece of hardware with their software." Also, he thinks the cost of the devices—right now, between $10 and $50—is prohibitive.

Even if successful, the Adapso concept will not be the end-all of software-protection schemes. "Part of our philosophy is not to look for a bulletproof device," says Goldyn. "We don't want to build a trench. We want a speed bump." Goldschmitt agrees. "We could get a lot more complex with this. But our general position is to provide users with the basic freedoms they need—backup copies, use on LANs, rentals. Then most people will have what they want and illegal copying will become not very convenient." ☐

SEMICONDUCTOR PROCESSING

FRONT-END AUTOMATION CATCHES ON

Los Angeles

More and more, chip makers that want to automate front-end processes can select rather than settle. Already, two West Coast firms have delivered gear that takes workers out of clean rooms for wet processing of wafers. And late last month, Veeco Integrated Automation Inc., Dallas, showed its new line of Class 10 fab-automation systems, which hustle wafers from one processing station to the next without the showers of particulates that humans give off.

Of the many steps in semiconductor-wafer fabrication, wet etching is one of the nastiest and perhaps the thorniest to fully automate. But Intelledex Inc., of Corvallis, Ore., and the Process Systems Division of Fluorocarbon Corp., Anaheim, Calif., have designed equipment that does it. Fluorocarbon, the integrator for the Fluorocarbon/Intelledex system, makes the gear for wafer cleaning and rinsing, along with particulate-detection hardware. Intelledex makes the robotic and vision systems.

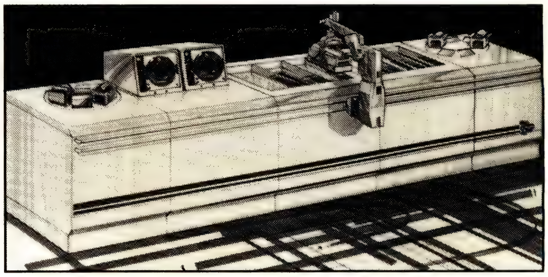
Signed up. The unit already has a heavyweight buyer. Two systems have been shipped to Texas Instruments Inc., and a total of seven will be delivered by mid-May. TI will use them in its new 6-in.-wafer plant in Dallas. Similar systems will also be used in TI's facility for twin-wafer fabrication in Japan.

This advance in wet-processing automation surprises even consultants involved in this facet of semiconductors. Will Strauss of Forward Concepts Inc. sees it as significant for two reasons. "It's important because no one else has taken automation this far, to my knowledge." Also, it shows that wet processing, despite all the drawbacks of handling toxic chemicals, still is not being displaced by dry techniques—"and probably won't be for at least five years," he maintains.

The new system uses an Intelledex 605 robot arm that runs on 12- to 20-ft tracks beside each work station to move cassettes laden with wafers through various tanks. Under control of a host computer (not included), the robots can reach into all tanks in the stations to position wafers through the cycle.

The robots monitor such variables as fluid levels and acid-bath temperatures and make decisions about them such as "timing the movement of cassettes from tank to tank, and selecting the proper recipe [process specification] for a given lot," says John Breslin, sales manager at Fluorocarbon.

Big dipper. A robot arm running on a tank-side track moves wafer-laden cassettes in and out of etching and rinsing baths. The robot also monitors fluid levels in tanks.



For the user, the payoff from automation goes beyond the saving in cutting the number of people necessary in wet processing, the two firms have found. This varies, but could amount to a "tenfold improvement in some cases," says Breslin.

Another benefit is that the system protects humans from toxics—"one of the most advantageous things about the system," notes William Mahoney, Intelledex marketing vice president. "We don't want humans handling those toxic chemicals."

Veeco helps banish humans from clean rooms with its line of Veebot automatic guided vehicles, some of which are fitted with robotic arms to load and unload wafer cassettes. The Veebots are controlled by a central computer, and ply their routes between intelligent material-storage stations that read bar codes and report back to the central controller.

The first completely automated fab system is set for delivery in three months to Fairchild Camera & Instrument Corp.'s Portland, Me., plant. Starter systems cost about $500,000, Veeco estimates; advanced systems run about $2 million. Veeco says its material movers, robotics, and controlling computers can save a fab-line operator up to $6 million in a year.

–Larry Waller and J. Robert Lineback

MILITARY

MICROWAVE LANDING SYSTEM'S PLANS REVIVED

Hanscom AFB

The Department of Defense is poised to start moving again on long-stalled plans for its Microwave Landing System for airplanes.

The Air Force Systems Command's Electronic Services Division has for some time been developing requirements for the program, which would replace existing military instrument landing systems. Those requirements will be reviewed next month by the House Armed Services Committee, and requests for proposals could go out as early as April 30.

According to preliminary estimates, the program would cost $1 billion between now and 1992-93, mostly for avionics. Lt. Col. Rodney Sayles, MLS program director for the DOD, says the system will provide up to 200 channels and allow

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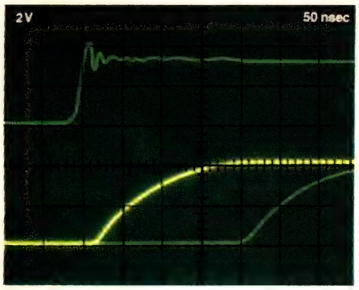

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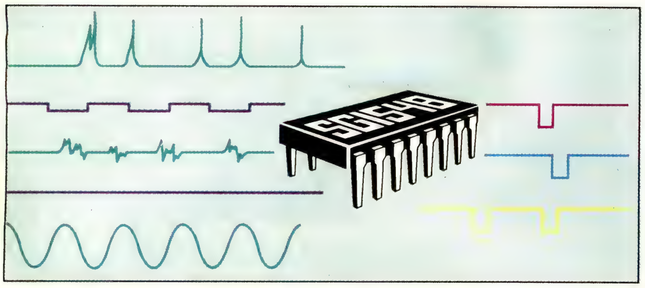
A new quad function fault monitor—the SG1548. This is the first precision monolithic device capable of monitoring four independent DC supplies and the AC line. Individually programmable fault windows are controlled by a precision low drift reference. A time delay can be programmed to ignore intermittent and synchronous noise in the DC lines.



The SG1548 monitor simplifies power supply design by integrating four DC fault detectors into one chip.

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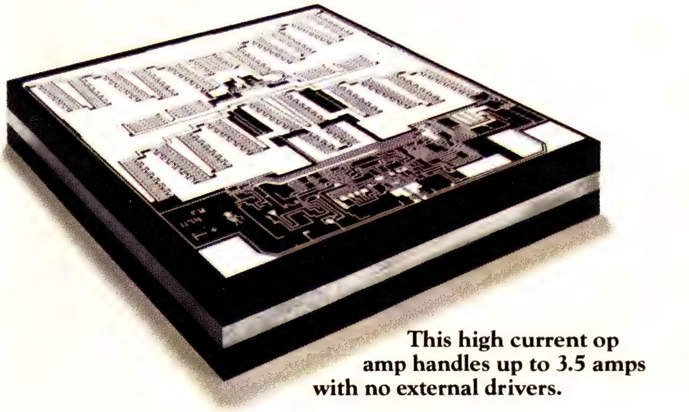

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Circle 24 on reader service card

Landing officer. Lt. Col. Rodney Sayles is trying to get the Defense Department's long-stalled MLS program moving again.

curvilinear landing approaches. The system is also less sensitive to ground interference and will cost less to install than existing systems.

The program's first phase will concentrate on developing a portable, lightweight tactical system and on modifying commercial avionics systems for military use. To cut costs, Sayles says, the military will make as much use as possible of available commercial microwave systems.

The biggest development hurdles will be in weight reduction and reliability. Tentative requirements call for a modular system weighing under 500 lb, with no one part in excess of 120 lb. Commercial systems, by contrast, weigh nearly 2 tons.

Dual capability. Unlike conventional systems, the military's system will place azimuth and elevation antennas at the same location. This will necessitate off-set calculations to center landing aircraft. And because both instrument and microwave landing systems will be in use for the foreseeable future, Sayles says, receivers on fighters must have the capability to handle both.

The DOD wants to build seven prototype ground stations and 40 receivers. Sayles estimates the cost of the development program at $25 million to $30 million and says the total program should run 30 months. At least five major contractors are expected to compete for the development contract. Ultimate production targets call for more than 200 systems for the Army and Air Force.

The program's later phases will include the development of a shelter-housed MLS as well as of a fixed-base landing system. **–Craig D. Rose**

PACKAGING

NOVEL LEADFRAME CUTS CHIP-CARRIER COSTS

Anaheim, Calif

Through an astute blend of leadframe and plastic-molding technologies, engineers at GTE Products Corp. have dramatically cut costs of plastic chip-carriers having high lead counts. Their money-saving combination: splitting the leadframe into quadrants and holding the leads in place by carrier strips until assembly.

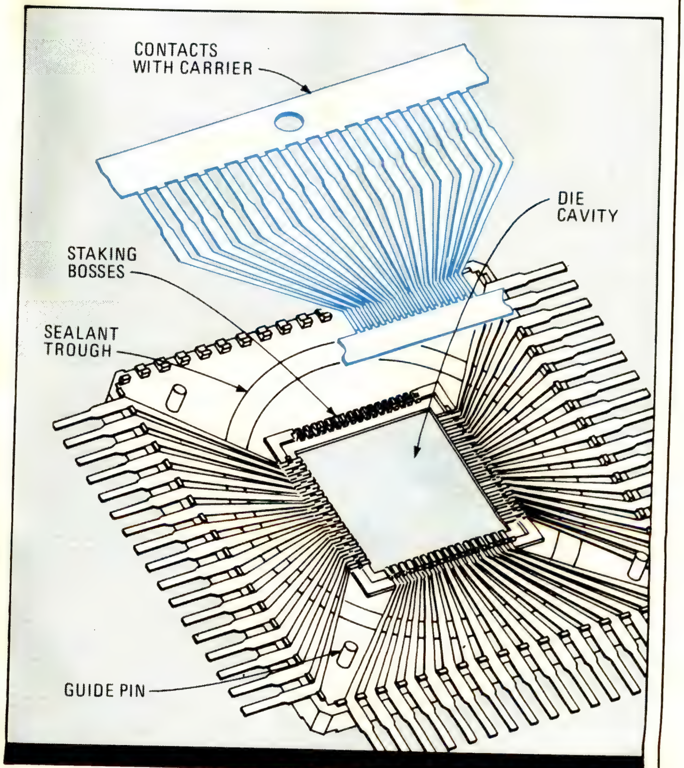
GTE unveiled its J-leaded, 68-pin package at the Nepcon West show here in late February. The package is designed to conform to the Joint Electron Device Engineering Council's standards for chip carriers for either surface or socket mounting.

The Warren, Pa., firm had to solve the primary problem of high tooling costs and assembly difficulties inherent in four-sided leadframes of 68 leads or more. As the input/output pin count of an integrated-circuit package gets higher, it becomes more difficult to maintain lead alignment and coplanarity because of the high lead count. And finally, during the assembly of a conventional plastic chip carrier, leadframes must be handled several times before they are ready to put in place, which risks damaging the leads.

Tooling costs are a long-standing problem as well, points out Richard Johnson, the engineer who is in charge of new products at the company. A tool for a 68-contact leadframe will have

about 145
about 30 in. ches, will measure
about $150,00 length, and cost
price for an eve explains. The
complex tool for ger and more
frame was recently contact lead-
about $200,000 with to GTE at
it would work," he a uarantee
So GTE's designers,
ground in connector
came up with a design th ack-
68 leads into four identical y,
(see figure). The single tool
to produce them costs only
$35,000.

To simplify assembly, the q
rant frames are attached on b
ends to carrier strips. These ensu
that lead configuration and coplanarity will not be compromised before assembly. In addition, the carrier strips allow the quadrant leadframes to be metal- and solder-plated before assembly. **–Jerry Lyman**



Quadrants. By splitting the leadframe into four parts, GTE Products slashed costs for a 68-lead plastic chip carrier.

PRIVATIZATION A U.S. BUST

Tokyo

Japan's new era in ommunica- le of weeks tions is just a o many U.S. from inception, stry officials, it government an e an old story. may turn o rogress," said Un- "We have Commerce Lionel der Secr week. "I am encour- Olmer couldn't report that aged had agreed to a single t for less regulation.

th eek, Olmer will be back in or the second formal round ks with Japanese government rs about opening the telecom- nications market. The administra- ve ordinances related to Japan's ew telecommunications laws may e submitted to Prime Minister Ya- hiro Nakasone's cabinet for final pproval.

A lot of talk. "They talk of pro- ess and agreements," said a source ose to the negotiations. "But we ven't got anything in writing yet. hose young, tough bureaucrats at PT [the Ministry of Posts and lecommunications] are just sitting ck and waiting for time to run out. t this point, we're looking at a mar- t that could be administered just out any way MPT wants."

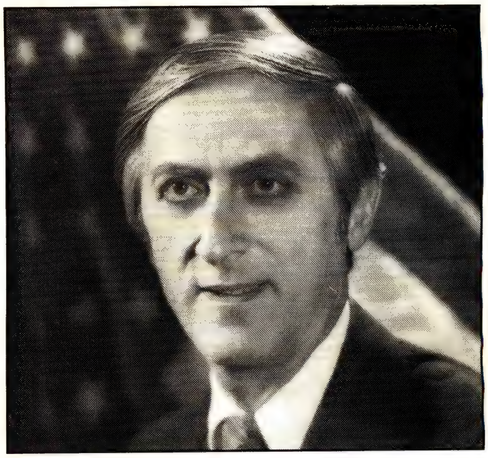
According to a senior U.S. govern- ent official, one of the serious regu- tory problems for U.S. firms is the quirement that companies in the new value-added-networks market provide "elaborate descriptions of their business plans, details of their equipment design, and perhaps even a rundown of their potential or actual customers. And if they wished to expand their business, they would have to submit another application."

NTT picking. Another key U.S. objection is in product certification and inspection, in which an industry group would be responsible for all analog equipment. "The problem is that about 99% of the Japanese market is analog now, but by 1990, it is estimated that the networks will be 20% to 30% digital," said the same official. Moreover, under the proposed ordinance, all digital-equipment certification would be handled by none other than Nippon Telegraph & Telephone Public Corp., soon to become a privatized group under another of the new telecommunications laws.

Still another U.S. objection is that under this ordinance, NTT itself would be exempt from equipment inspection. "In effect, it would give it [NTT] the right to look at its competitors' equipment and then plan its own marketing strategy accordingly," said the U.S. official.

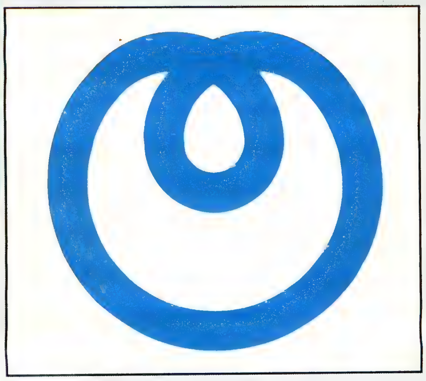
Other U.S. objections concern apparent loopholes that would allow NTT to use funds from its common-carrier business to subsidize its activities in value-added networks. The Japanese have given assurances there will be no cross-subsidization, but U.S. Embassy officials say they are studying the ministerial ordinances to see whether that is properly written into them.

Another requirement calls for value-added networks to have a chief telecommunications engineer, with a license granted by MPT. The vague language could allow MPT to insist that the engineer take a test in Japanese. One U.S. electronics executive here said, "In other words, we'd

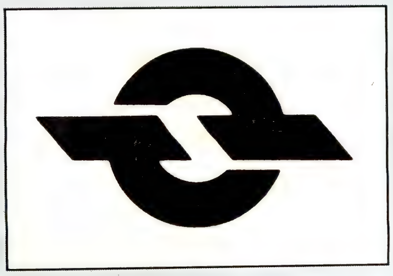


No change. Commerce Under Secretary Lionel Olmer couldn't cite a single Japanese deregulation.

NTT's new logo—a symbol of change



The death of an old and familiar logo can be as traumatic or exciting as the corporate struggles behind the change. AT&T Co.'s image was altered overnight when it replaced its homey and historic bell with an ultrastylized globe. NTT went the other way, handing Japan's leading graphic designer, Yusaka Kamekura, the task of changing its slick *den-den kosha* (Telegraph & Telephone Public Corp.)—with its minimal design and hint of two-way communication (right). He came up with a calmer corporate symbol, soft and curving, but with lines of communication less well defined. —**Jesse J. Leaf**



have to hire some guy who used *to* work for NTT."

The three laws, all of which take effect April 1, are led by the NTT Privatization Act, which will turn this public corporation into a private one and end its monopoly on the telecom market. With 320,000 employees and annual sales of approximately $20 billion, NTT will have to compete with the private makers in all the traditional markets it once dominated (telephones and satellites) and the new ones, such as value-added networks.

Half and half. The law calls for 50% of NTT's shares to be sold to the public within five years (subject to review in three years), while the government retains the other half. It will retain an unspecified majority in perpetuity, meaning that it will still call the shots. (Foreigners will not be allowed to buy NTT shares.) Moreover, the government will have the right to approve the privatized NTT's officers, so it will have a great deal to say about how the company is run.

The second major law, the Telecommunications Enterprise Act, sets out guidelines for the new market, divided between Class I common carriers, a category in which foreign firms can hold no more than one-third participation; and Class II, further divided into types of value-added networks. Foreign firms are allowed 100% ownership.

Class II General are smaller networks, while Class II Special are termed big VANs, such as the GTE Telenet. The new law says a VAN is a Class II Special if it has international links; has many and unspecified customers (in other words, it is a commercial VAN); or if it has more than 500 lines operating at 1,200 b/s.

This last provision has the U.S. negotiators up in arms because they think it sets much too low a limit. Because Class II Special equipment will be subject to much more scrutiny and control than Class I General, the U.S. is complaining that the 500/1,200 limit is "arbitrary, artificial, and baffling."

The third law, an Omnibus Act, is an administrative housekeeping law amending various existing legislation to conform to the new market conditions.

U.S. executives here are cautious about speaking openly about what will probe
Japanese nego
these new laws.
Hayde, chairman of Burr
in Japan and president of the U.S.-
can Chamber of Commerce in Japan,
says his firm would have to reconsid-
er its basic Japanese import policy if
faced with that type of detailed prod-
uct examination under the proposed
ordinances.

The final
U.S. officials lmer and other
discuss U.S. ac unwilling to
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the final test will co table re-
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One hint of this poli
seen in the satellite mar
were rumors that U.S. requ
MPT adopt a more flexible
on waveband use were getting
able results. "We had a meeting
week, but the Japanese government
simply repeated its position of last spring," said a U.S. official. The position is that Japan should purchase domestic satellites, not foreign-made models.

–Michael Berger

COMPUTER-INTEGRATED MANUFACTURING

MIGHTY MINIS TARGET INDUSTRY

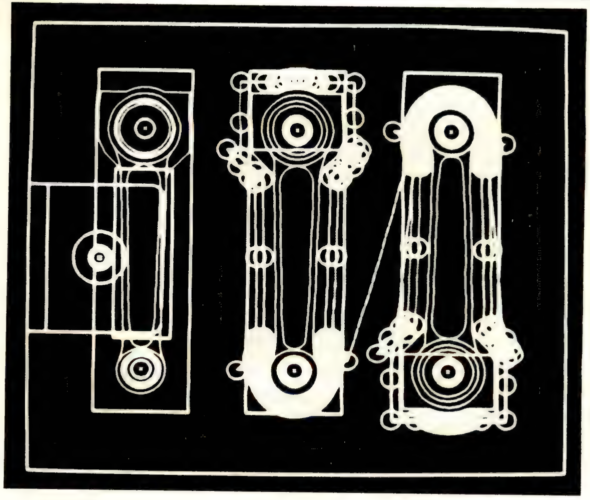
Minneapolis

Everyone agrees on the need for computer-integrated manufacturing, but whether anyone has actually implemented it is still a matter of who you talk to. Now Control Data Corp. is on the verge of making the new technology a reality.

By expanding its use of four strategies—investments, licensing, joint ventures, and product enhancements—Control Data will "aggressively pursue applications for computer-aided design on the factory floor," says Alan Christman, manager of CIM marketing for the firm.

New focus. Indeed, if the present trend continues, the Midwestern computer giant will be moving its market focus away from mainframes, its traditional bread and butter, and toward smaller computers aimed primarily at the integration of design with manufacturing—in other words, CIM.

For example, the company has invested $1.2 million in Diversified Data Collection Systems, a Rochester, N.Y., startup that developed a protocol for collecting real-time data from different manufacturing work cells. "The key is integration," says Bill Jaques, CDC's general manager for electronic CAD, adding, "We want to design products with our customers—not just supply them with [electronic] drafting equipment."



Cutting waste. Designers can preview cutter paths with ICEM, enter changes before machining a part, or alter a machine's instructions while it is working.

To expand its capabilities in the development of next-generation electronic and mechanical CAD soft-

Corp.,
and elec-
ware, the company ha terms of the
a joint ventu ntrol Data provides
the software from its ICEM
ated Computer-aided Engi-
ring and Manufacturing product
line, which Northrop apply to
its aerospace devel programs.
Presumably, N has access to
proprietary otocols so that
it can suggestions for
modify that it does not
EM to compete with
s in CAD/CAM hard-
big three [Daisy Sys-
ntor Graphics, and Valid
re so well established in that
, we're better off by cooperat-
with them than we are by getting
the business ourselves." Thus

DC is entering into an agreement with Mentor Graphics Corp., that will tie Mentor's work stations into Control Data's new line of Cyber 180 computers.

Intelligent element. According to Douglas Scafe, general manager of computer systems product management at CDC, one of the most important applications for the Cyber 180 series is as the intelligent element in CIM-based production. "Any designer can port his designs from the low end of the 180 series [the Supermini 810] to the [quasi-mainframe] 990," Scafe explains. "This represents an increase in speed on the order of 1 to 60, the largest compatible growth path in the industry."

Making such flexibility a reality is an architecture that makes it possible to run two operating systems—the NOS (6-bit/60-bit words) and NOS/VE (8-bit/64-bit words) simultaneously—using the same core memory and central processing unit. Although only one program can use the CPU at a time, many programs may have peripheral processors performing operations for them.

This is especially useful in CIM because a complex task like fault simulation can be performed by the main processor while tasks that require less power, like downloading design instructions to a numerical controller, can be handled simultaneously by other processors in the same machine. **–David M. Weber**

VIDEO DISK, PERSONAL COMPUTER REPLACE LAB

New York

By combining little-used video-disk technology with the ubiquitous microcomputer, science educators at the University of Nebraska at Lincoln have created an interactive system for laboratory instruction that they say could help ease the shortage of adequate university lab facilities.

Called Interactive Videodisc Science Instruction, the system ties together a video-disk player, either an IBM Corp. Personal Computer or Apple II, and a color TV monitor.

A total of six introductory college-level courses are now available in physics, chemistry, and biology. Courses consist of the video-disk lesson presentation and computer software on a separate floppy disk to control the student's interaction with the disk. Most of the courses will sell for $425 apiece; production costs for one lesson range from $50,000 to $100,000.

Lab on disk. Using this interactive video system, a student can conduct experiments outside the lab.

"There is no replacement to actually going into the laboratory," acknowledges David W. Brooks, a University of Nebraska chemistry professor who helped develop the series. But Brooks says that for individualized lab instruction, "this is the most powerful tool I've ever used," and claims it shows a wider variety of laboratory conditions than previous teaching tools.

Ronald Nugent, director of the University's Videodisc Design/Production Group, which demonstrated the system here at the Institute of Electrical and Electronics Engineers headquarters, characterizes it as "a surrogate experience" to be used in school when laboratory facilities are unavailable or inadaquate.

Real advantage. However, Brooks and Nugent point out an advantage to the "real world" video-disk demonstrations versus traditional lab experiments. For example, the motion study uses a diver to illustrate the laws of motion rather than the standard steel ball experiment. They maintain that students more readily understand such demonstrations.

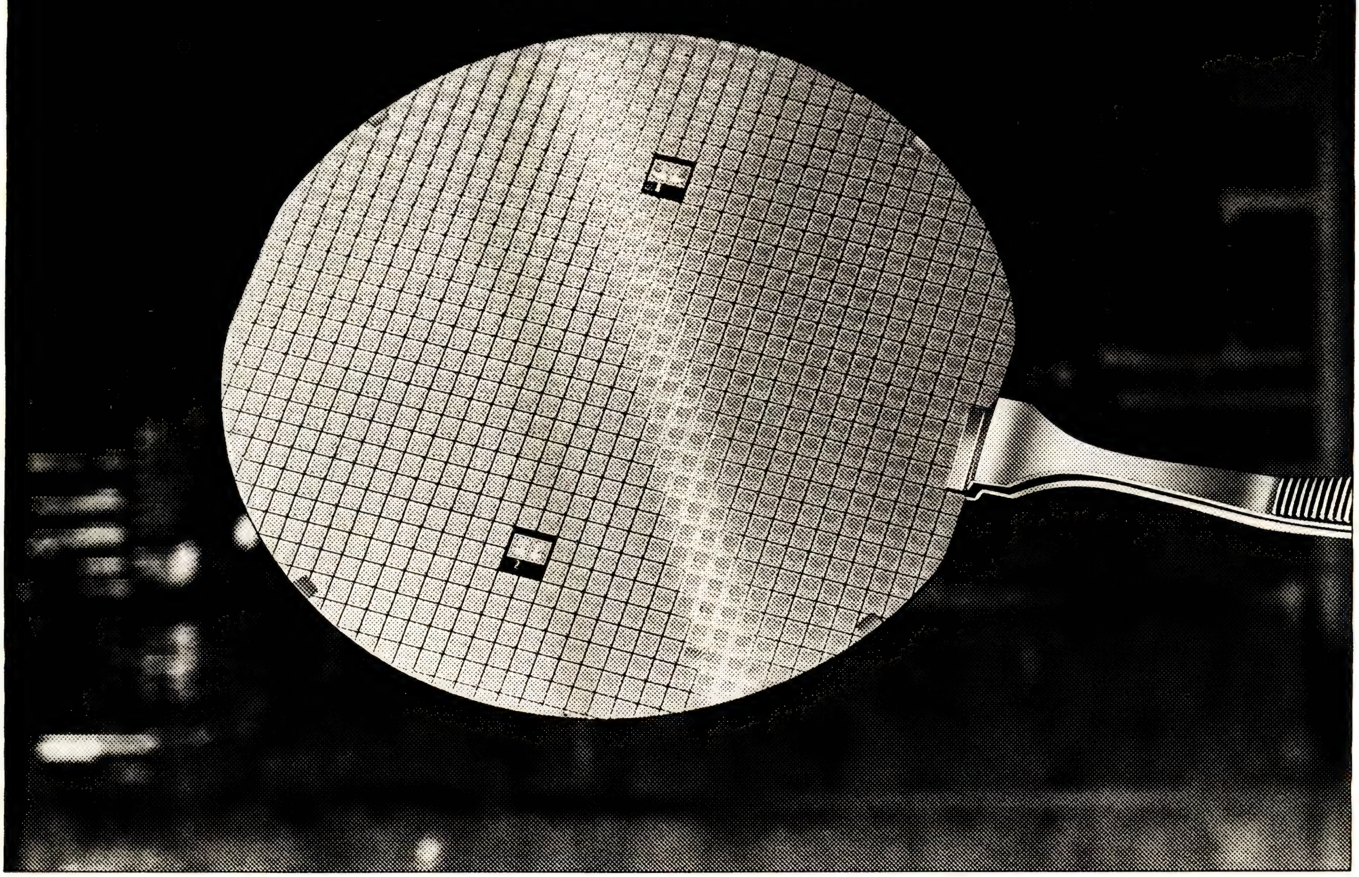
Through their individual computer keyboards, students interact with the experiment by selecting variables, interpreting data, formulating hypotheses, and answering questions flashed on the screen. Students are routed through tutorials if their responses are inadequate, Nugent adds.

With a capacity of 54,000 frames, the system can offer sophisticated courses, says Jack McBride, project director and general manager of the Corporation for Public Broadcasting (CPB) affiliate on the Lincoln campus. Software can individually address any of the frames as well as the disk's audio capacity.

Work on the video-disk teaching system began in 1977 when the University of Nebraska, long involved in interactive teaching through its educational TV network, was approached by CPB to carry out a five-year research and development program. In 1981, funding and administration of the project were assumed by The Annenberg/CPB Project, which operates under a $150 million grant from The Annenberg School of Communications of the University of Pennsylvania. **–George Leopold**

THE BEAUTY OF AUSTRIA

(As seen by AMI.)



Behind the dazzling scenery and Viennese waltzes beats the highly industrialized heart of Europe: Austria. Second only to Japan in growth of GNP, productivity and export sales.

American Microsystems have just built their sole European integrated circuit design and manufacturing facility just outside Graz, Austria's second largest city.

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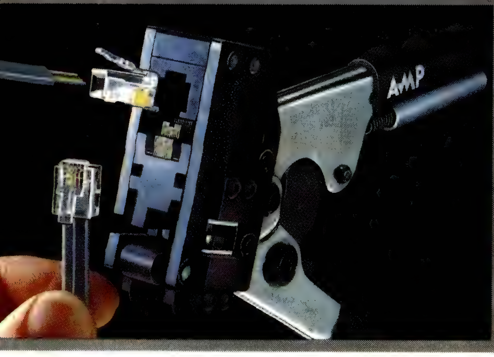
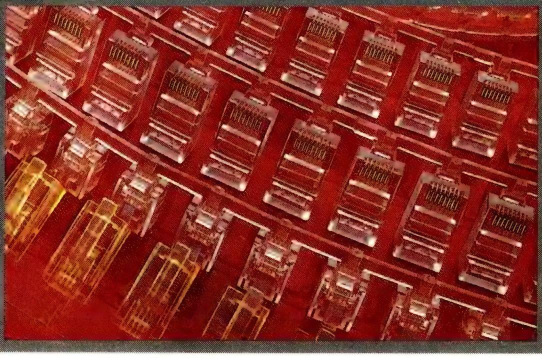


The AMP Modular Plug hand tool cuts, strips cable jacket, and terminates loose piece plugs. Accepts 2, 4, 6 or 8-position connectors with quick-change dies.



AMP modular plugs in strip form for termination with AMP high-speed application tooling.

AMP modular jacks feature high reliability. U.L. listed in top-entry and flanged or flangeless side-entry versions.

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TOXIC CHEMICALS JAR INDUSTRY

Chip makers face action by government agencies and citizens' groups, as well as possible suits over worker safety

☐ by Clifford Barney

Palo Alto

For years, the semiconductor industry enjoyed a reputation as an environmentally benign savior of the economy. Not any more. Now it is struggling to find new ways to handle and dispose of the toxic chemicals that are essential to the fabrication of its product.

First of two articles.

As residues of these chemicals began to turn up in municipal water supplies, public opinion began to change. Government agencies of every stripe have taken action to force the industry to clean up its act, and the industry itself has begun spending more money and devoting more personnel to the task.

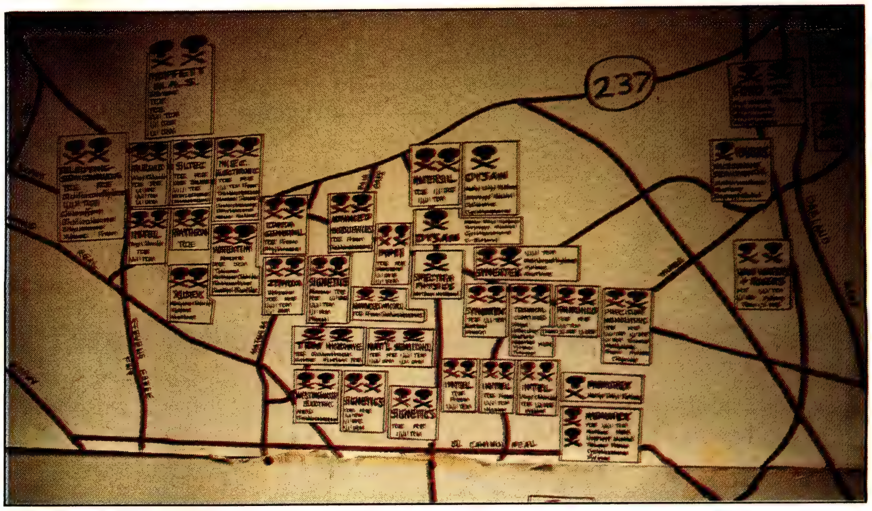
Such actions result from recent incidents across the U.S:

- In Massachusetts, exposure to arsine gas has caused two deaths in the past two years. Also, several towns along Route 128 have had to replace sewer lines and close wells.
- In Texas, a large number of employee illnesses have been reported at a semiconductor plant, and many communities are currently carefully

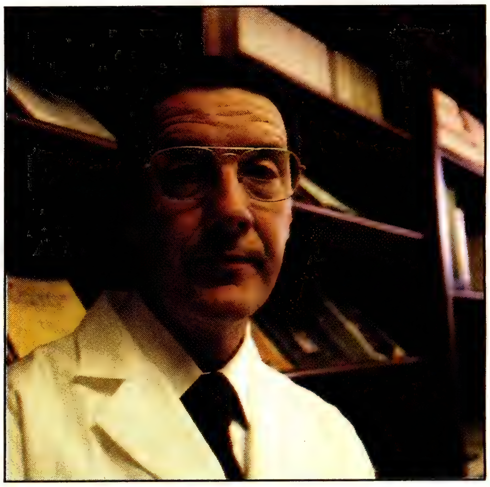
monitoring their water supplies.

- In Arizona, a spill was discovered in Phoenix, and tanks and a building have been removed.
- In the Los Angeles area, toxic solvents were spilled from a plant where printed-circuit boards are manufactured.

But nowhere is the action more heated than in California's Silicon Valley (an aerial view is shown on the facing page), which boasts the world's highest concentration of semiconductor manufacturers. As if trade deficits and Japanese competition weren't enough, the electronics industry there got a rude shock last month when the respected California Poll reported that 59% of all Californians think that the growth of high-tech industries poses a severe threat to the environment because of their use of toxic chemicals.



Marking the spots. The map in the office of Ted Smith, head of the Toxics Coalition group of the Santa Clara County Center of Occupational Safety and Health, gives the locations of toxic waste sites as well as the chemicals involved at each. Also delineated are carcinogenic chemicals.



Warns of hazards. Dr. Joseph LaDou, acting chief of occupational and environmental medicine at the San Francisco Medical Center, says toxic chemicals are more of a health hazard than the industry realizes. He says faulty reporting techniques make the record appear better than it is.

Hundreds of leaks. The poll reflected the widespread publicity that has attended leaks of chemicals at firms in Silicon Valley, where the water supply has been penetrated by a few leaks and threatened by hundreds more.

The uproar over environmental pollution has been paralleled by a less publicized but extremely heated controversy over the health of semiconductor-industry workers. The industry thus finds itself embroiled in chemical warfare on two fronts—one outside and another inside the plants.

Outside, chemical leaks have required enormous cleanup operations and engendered new storage regulations that have added significantly to costs. Inside, the need to protect workers from the same chemicals has brought about the development and installation of elaborate—and expensive—safety equipment.

The industry has at times found itself at odds with state and local governments, though it can also point to a long record of cooperation with them. It has attracted a flock of environmental watchdogs, some of whom it believes are scouts for the labor movement. It has also set up its own environmental committees as forums for industry cooperation in helping to solve the environmental problems.

A whole new subindustry is blossoming to provide solutions to what everyone sees as a very serious problem. Not the least of the problems is that it's all costing money. "The bottom line is [that] the bottom line is suffering," says Dan Rose, publisher of a newsletter called "Electronic Materials."

"No other industry on earth uses nastier chemicals than the semiconductor industry," Rose points out. This fact has never been hidden, but in the past year there has been a rising chorus of concern over its implications with respect to health and environmental safety.

The environmental issue is the aftermath of two well-publicized toxic leaks at plants south of San Jose, Calif.—incidents that led to the discovery of hundreds more. On the other hand, the question of worker health is not so clear-cut and is in fact a matter of hot dispute.

Last spring, Dr. Joseph LaDou, the acting chief of occupational and environmental medicine at the University of California's San Francisco Medical Center, wrote in the Massachusetts Institute of Technology magazine *Technology Review* that the toxic chemicals used in making wafers were more of a health problem than industry realized.

LaDou contends that long-term low-level exposure to toxic fumes may have severe effects on workers, and that the industry is hiding the evidence from itself by its way of reporting occupational illness. He is particularly concerned with the effects of chemicals on the reproductive process, because women make up such a large percentage of the fabrication-area personnel.

High rate. To prove his point, LaDou points to state and federal figures on occupational illness, which he says show that the rate of illness in the semiconductor industry is three times that of all industry. No studies of industry worker health exist, and the issue that LaDou raises has been clouded by a dispute over what constitutes an illness.

Although the industry has acknowledged responsibility for chemical spills and has actively supported legislation designed to prevent them, it does not do the same in the area of health and safety. The Semiconductor Industry Association has published figures that it says show semiconductor manufacturing to have one of the best such records of all occupations.

Notwithstanding this official position, whether because of outside pressure or internal concern, semiconductor makers are paying more attention to worker health and safety. Many companies are rapidly installing safety equipment such as monitors for toxic fumes and computer-controlled containers for cylinders of toxic gas (see story below). The SIA has even quietly sponsored research on reproductive effects.

The chemicals in question are those acids, gases, and solvents used in every phase of semiconductor manufacture, from the silicon ingot

FOR AMD, THE COST IS COMPOUNDED

Leaks and spills are becoming a heavy financial burden for semiconductor companies in more ways than the obvious costs of cleaning them up. The price of insurance for what is known as environmental liability has increased at least tenfold in the past two years. But at Advanced Micro Devices Inc., legal expenses are running far higher: the company is suing its insurance carrier for not paying what it considers a legitimate cleanup claim.

"We filed a claim for on-site coverage cleanup, they denied the claim, and we've sued them," says Rich Lovgren, AMD corporate counsel, of the company's disagreement with Great American Surplus Lines Insurance Co. Lovgren says he hasn't wanted to talk about the suit, which was filed in the summer of 1983, before now. "But I have a strong moral and ethical objection to what they did, so now I want it in the open."

No one at the insurance firm's home office, in Cincinnati, or at Great American West, its San Jose, Calif., affiliate, would talk for publication about the case. An underwriter for the company would not even say if it still covered semiconductor firms for environmental liability in California (Lovgren says it does not). "That's a risk-to-risk underwriting decision," says the representative.

Lovgren says AMD purchased the liability coverage through Great American in the spring of 1981, for "just a shade over $10,000 in premiums." After filling out an application, AMD was granted $10 million of environmental liability coverage through Great American and another $10 million through a secondary carrier. The policy covered some $1 million worth of on-site cleanup, according to Lovgren. He says AMD's record was good enough that its policy was renewed at a cheaper rate the next year. Great American dropped the second carrier and assumed the entire $20 million liability itself.

Great American granted the $20 million policy both initially and at renewal time solely on the basis of AMD's application form, says Lovgren, without ever conducting an on-site inspection. When AMD filed a claim in spring 1982 for its highly publicized on-site cleanup operation on Duane Avenue in Sunnyvale with Signetics Corp. and TRW Inc., the insurance company promptly denied the claim. "Their stated reason for denying the claim was [that we had] prior knowledge of the spill before taking out the insurance," says Lovgren. "My cynical side says they'd rather pay $50,000 to defend a suit than pay out $10 million for acting in bad faith, along with the $1 million on the policy."

Although many semiconductor firms, including Signetics, would not talk to *ElectronicsWeek* about the use of toxics inside their plants, AMD did. The company once had a fairly bad reputation among workers for its handling of dangerous substances, and along with Signetics and TRW was accused of stalling on the Duane Avenue cleanup. Nonetheless, AMD environmental manager Mike Gingrass spoke freely about the spill and cleanup in Sunnyvale and how he believes AMD now protects its workers.

The back lot at AMD is testimony to AMD's checkered chemical past. An L-shaped row of metal plates covers the site where 6,000 cubic yards of soil contaminated with trichloroethylene was excavated and the hole refilled. A huge fenced-in area houses a carbon-filtration unit, which holds 40,000 pounds of carbon and cleans 175,000 to 200,000 gallons of water a day, pumped from the contaminated aquifer at Duane Avenue. And concrete vaults line any area where conduits or vats move or store acids before disposal, so that leaks can be spotted more easily. The cleanup has cost over $1 million. "All spills cost that much," says Lovgren. "The million-dollar club is easy to join."

"The original acid-neutralization system was installed when the facility was first constructed," says Gingrass. "It was a direct-bury three-tank system with no vault and no secondary containment. The first tank corroded and sprang a leak. Evidently, solvents, which had been introduced into the system either through mistake or dragout through the wafer boats, escaped into the surrounding soil and went into the upper layer of ground water." (Dragout occurs when wafers are submerged in a chemical bath for etching or cleaning, and a finite amount of material stays on the wafer boat and wafers. This material is then "dragged" down the acid-neutralization pipe.) Now, AMD has electronic sniffers—which cost $75,000 each—that tell when anything leaks, he says.

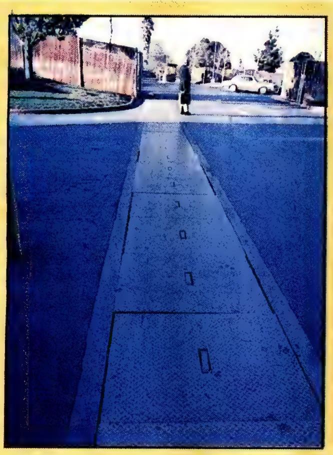
Inside the plant, workers learn how to handle the chemicals in training programs, conducted either by paid staff or by specialized contractors, Gingrass says. The company also uses chemicals in the smallest amounts possible. "It's more costly and less efficient, but much safer when you have to clean something up," he explains. Standard protective gear—gowns, glasses, protective gloves, plastic sleeves, and face shields, as well as sinks with special hoods and shields—is in place in all clean rooms or where toxics are used.

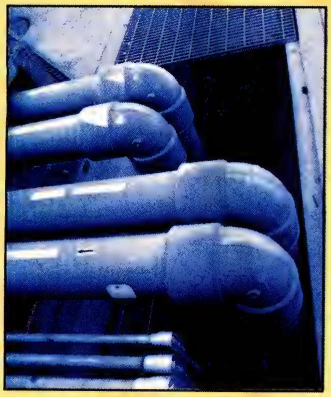
In addition, toxic gases vented from clean rooms are exhausted to a scrubber system, where they are wet-scrubbed before being released to the atmosphere. Laminar-duct air-flow systems are supposed to keep particulates isolated in the work area. But they may not be as effective as believed. Because many precautions that semiconducto the finished chip. They are:

- Sulfuric and hydrochloric acids are used in cleaning chips, and hydrofluoric acid in etching them. They are all irritating to skin, eyes, and the respiratory tract. Hydrofluoric acid also attacks bones.
- Silane, arsine, and phosphine gases are used for doping and fluorinated hydrocarbons for plasma etching. Silane is pyrophoric—that is, it can ignite spontaneously—and is blamed for an explosion that destroyed an Oki Semiconductor plant in Japan. Arsine, one of the most toxic of all, has a number of systemic effects and breaks down to arsenic in the body.
- Organic solvents, which are used in vapor degreasing, pose one of the toughest problems of all because they can't be neutralized. They are blamed for cancer and birth defects as well as for systemic illnesses.

With the issue more serious than ever after four years of cleanup, the SIA last month hired an expert from the chemical industry itself as its director of environmental and occupational safety and health affairs. He is James T. Dufour, a lawyer and industrial hygienist from the Stauffer Chemical Co.

"It's become obvious to us that





Prevention. AMD has so far spent over $1 million to clean up its area. Metal plates cover an area excavated because of leaks (right). Pipes are now in concrete trenches to make leaks easier to detect (middle). Acid neutralization tanks are vaulted in concrete (bottom). Mike Gingrass, corporate environmental manager for AMD, shows scale of the carbon filtration tank (far right).

tor firms use benefit the chips as well, some observers say they are not really worker-protection systems.

But AMD claims that four phosphine-arsine detection units, solely for worker protection, are already in place inside the plant, and 10 more are being installed now. At a cost of $25,000 apiece, they constantly monitor gas levels around such instruments as ion implanters. "We also have very conservative evacuation policies," he says. "An alarm goes off when the level of toxicity in the air reaches 25% of Occupational Safety and Health Administration standards, and we actually evacuate at 50%. The overriding rule is that at any time he feels he is in danger, the worker has the right to leave the area."

Despite its efforts, AMD—like most semiconductor firms that have been nailed as contaminators—will probably spend the rest of its corporate days watching money for cleanup flow almost as freely as clean water from its carbon filter system. "The technology works against us," says Lovgren. "When we first started pumping that aquifer [at Duane Avenue], the unit of measurement was in parts-per-million. Now we're talking about parts-per-trillion. Detection devices are improving very quickly."

–***Denise Caruso***

we need a qualified professional to advise us," says SIA president Thomas D. Hinkelman.

Dufour sees the semiconductor industry as a hapless user caught up in a problem not of its own making. Compared with what chemical manufacturers are facing in New Jersey, Pennsylvania, and Florida, he says, "this industry doesn't really have a problem." But no one questions that the industry, its former clean image tarnished, needs some help.

Long list. The list of toxic-spill sites in Silicon Valley reads like a who's who of the semiconductor industry. There are more than 300 known spills, with new ones being found every week.

The most severe leaks, besides the original ones discovered in South San Jose, are in Sunnyvale, where Advanced Micro Devices, Signetics, and TRW have agreed to share responsibility for a cleanup, and in Mountain View, at Fairchild, Raytheon, Siltec, Intel, and NEC sites. These spills have caused the closing of 50 private and public wells. (The Sunnyvale leaks have not reached the water supply.)

The worst leakage into the water supply occurred at the Fairchild Camera & Instrument Corp. plant in San Jose. One well that supplied drinking water to the surrounding community was subsequently found to contain over 8,000 parts per billion of a solvent known as 1,1,1-trichloroethane, or TCA. Santa Clara County requires cleanup action at 5 ppb. The well was taken out of service.

The California Department of Health Services later performed two controlled epidemiological studies on women who conceived during a two-year period before the leaks were discovered. The studies showed that the rate of spontaneous abortions in the district around the well was double and the rate of congenital heart defects triple those of the control group.

The studies were carefully drawn to exclude other maternal risk factors. However, because the pattern of the reproductive problems in the area studied did not match the distribution of water from the contaminated well, the department stopped short of tying the defects directly to the water. Followup studies are planned.

The leaks at Fairchild and at a nearby IBM Corp. plant prompted a state survey of other plants in Santa Clara County, which turned up 89 more and triggered a massive response on the part of all levels of government and in industry. Last July, the various government agencies came together in the South Bay Ground Water Contamination Task Force to achieve some kind of coordination.

The federal Environmental Protection Agency has listed 19 of the sites as candidates for its Superfund. It is also conducting a study of the area's risks from toxic pollutants in the air and groundwater as one of its three Integrated Environmental Management Projects. (The others are in Philadelphia and Baltimore.)

New law. Semiconductor firms joined with other industry associations in the Industry Environmental Coordinating Committee to help write a model ordinance for the storage of hazardous materials (since adopted on local and regional levels and as state law) and a model building code. Industry has also funded the Clean Water Task Force to monitor and report on the cleanup. Individual companies have performed extensive cleanup operations, although at first some of them were criticized for arguing over which one bore responsibility for untraceable spills.

In addition, labor and public-interest groups such as the Silicon Valley Toxics Coalition have kept up public pressure. When the Sunnyvale leak was found to be spreading toward residential areas last summer, the Toxics Coalition drew more than 100 people to a protest meeting in a Sunnyvale church. They heard former semiconductor workers tell of being ordered to

WHEN ALARM SOUNDS, CHEMISTS ROLL

Santa Clara, Calif., home to more than 300 electronics companies in the heart of Silicon Valley, may be the only city in the world whose fire department has its own chemical division. Formed four years ago after several firefighters were injured when they responded to chemical spills, the division now includes three full-time chemists. At least one is always on call.

The division's operating budget this year is $240,000, which covers the salaries of the three chemists (two of whom have PhDs) plus equipment and support staff. The equipment includes a specially equipped van with self-contained breathing apparatus and toxic-gas detectors. The van can reach any place in the city in 7½ minutes, and its response time to most companies storing hazardous chemicals is two to three minutes, the department says. Chemist Larry Monette says the van (see picture) responded to about 100 spills at semiconductor and printed-circuit-board plants last year.

The usual problem at semiconductor firms is a gas leak, Monette says. No firefighters have been injured since the chemical division has been in place, although some experienced temporary nausea when they were briefly exposed to gas leaks.

—**Eve Bennett**

Industry team. Thomas D. Hinkelman (seated), president of the SIA, and James T. Dufour, director of environmental and OSHA affairs for the trade group, say the semiconductor industry has a good health record.

pour chemicals into the ground. A representative of the Santa Clara Central Labor Council urged residents to pressure the legislature to force companies to spend more on cleanup activities.

They've already spent plenty. IBM says it has paid $42 million and Fairchild reports spending $23 million to clean up the San Jose spills. (IBM's diligence was rewarded last month when the state's San Francisco Regional Water Quality Control Board decided not to recommend that the state attorney prosecute the firm for allowing the spill in the first place.) The SIA estimates that in all, Silicon Valley firms have spent close to $100 million. And not only is the end not in sight, but it may never be in sight. "We'll probably never turn off that pump," says an AMD official about the Sunnyvale spill cleanup effort.

Is the cleanup working? "There's no question that the situation is getting better," says Donald Dalke, an engineer with the San Francisco Regional Water Quality Control Board. "We have major efforts at all known sites. All municipal suppliers routinely check their water. No major wells are known to be contaminated. Companies are more aware of the problems with storage tanks. So there's no way it can be getting worse.

"But there is one uncertainty," he adds. "Is there a major problem we haven't found yet?" Old spills are still being discovered at the rate of three or more a week, he says. The SIA points out, however, that none of the known sites is still leaking.

A bombshell? Ted Smith of the Toxics Coalition agrees that progress has been made in cleaning up the spills. But he says it is possible that only 10% of them may have been discovered. The Mountain View spill, Smith says, may be a bombshell just as shattering as the spills in San Jose.

Smith also notes that the ordinance requiring storage of hazardous materials in double-walled tanks is not retroactive. In addition, though all old tanks must be monitored, some owners may not comply with the monitoring requirement—and those who do may still miss some spills.

Dalke says that industry acts quickest when it is prodded by state agencies. But the regulatory system is extremely complex—Smith calls it "completely cockeyed"—with a dozen different agencies exercising different levels of control. For example, the water quality control board is responsible for maintaining the water supply. But once toxic chemicals are introduced into it, the Health Department acquires some jurisdiction.

Single agency proposed. To ease that situation, California Gov. George Deukmejian has proposed the creation of a single Department of Waste Management for the state, formed from a dozen current agencies. The plan has met with little enthusiasm, however. Assembly Speaker Willie Brown has his own plan for reorganization, but SIA president Hinkelman says, "Neither the governor nor the legislature will be able to write their own ticket."

Thomas Leacock, city manager of Sunnyvale, gives Dalke's board credit for most of the leadership in organizing a cleanup. But he notes that it is severely understaffed. Although the board has requested that its 14-member staff be more than doubled, it is given little chance of getting the additional staff.

Sally Reed, head of the South Bay Task Force, likes Deukmejian's idea of a single accountable agency but is skeptical about its chances for early implementation. In the meantime, Reed's task force is considering a plan to make a single local agency, the Santa Clara Water District, responsible for overseeing Silicon Valley leaks. That would cost $3 million and require the hiring of more than 30 people.

Gas stations guilty. All cleanup calculations have a wild card—the size of the role played by leaks from the tanks at gasoline stations. Hinkelman says oil companies were the chief opponents of the hazardous-materials-storage ordinance that the state legislature passed last year.

What's more, at least 200 of the toxic leaks in Silicon Valley are from gas stations—although gasoline tends to float and thus does not penetrate the aquifers from which the water supply is drawn, as Dalke notes.

The EPA is preparing an overview of the entire problem of pollution in Silicon Valley in its Integrated Environmental Management Project. The project has been under way for a year, and a report on its findings is expected in about 60 days.

According to project manager David Morrell, the idea is to examine effluents and emissions with regard to population densities, exposures, and geography in a computer model that allows prediction of risk factors. The project consults monthly with local and county officials, who will

PROBLEMS, TOO, WITH PC-BOARD MAKERS

As public and official concern deepens over disposal of hazardous wastes generated by semiconductor manufacturers, state and local regulators have also begun to scrutinize the activities of another part of the electronics industry: makers of printed-circuit boards.

In Long Island, N.Y., as in other densely populated areas, the problems associated with organic chemicals and their effects on groundwater have been a long-standing concern. Here, since the 1970s, the improper and often unlawful disposal of metals, organic solvents, and waste water has resulted in a jail sentence for the president of one company, a $1 million fine that drove another manufacturer out of business, and a 45-count indictment against the former owner of a third.

The $4 billion-a-year pc-board industry is a major user of electronics chemicals. Among them are a variety of highly toxic solvents including trichloroethane, trichloroethylene, and hydrocarbons such as Freon used in etching pc boards. Metals used in the manufacture of boards are often rinsed away with solvents in the etching process so that both end up in waste water. Solvents are of particular concern, say Long Island health officials, because they are in widespread use and do not break down chemically after disposal.

EMR Circuits Inc. of Hauppauge was fined $10,000 last year for violating state water-pollution statutes; the firm's president, Stewart Wood, is now serving a 90-day jail sentence. According to Rocky Piaggione of the New York State Department of Environmental Conservation's Division of Environmental Enforcement, EMR repeatedly poured trichloroethane down a drain into a leaching pool, usually on Saturdays.

A Suffolk County health official, William C. Roberts, says the county tried to handle the matter as a civil case, but EMR continually violated regulations by reopening and cementing over the leaching pool. "My impression is that this is a widespread problem," says Piaggione, who adds that a half dozen other cases are being investigated.

A second Long Island pc-board maker, 3-Dimensional Circuits Inc., formerly of Plainview but now out of business, received a $1 million fine last year for illegally dumping untreated waste water at a rate of 35,000 gallons a day over a five-year period. Generally, says Peter Mancuso, a Nassau County assistant district attorney and chief of its Environmental Protection Unit, "printed-circuit-board manufacturers would appear to have a good share of the responsibility for the water pollution." He also says he is investigating other cases, some involving board makers.

Alhough the first two cases were monitored by state and local agencies, another instance of alleged dumping appears to be more blatant. Before Mario Lombardo sold his interest last March in Circuitron Corp., a pc-board maker in East Farmingdale, state officials say copper, lead, and phenol were dumped into a pool under the plant's floor.

This pool and two more adjacent to the factory were discovered by the firm's new owners, ADI Electronics of nearby Ronkonkoma. According to Frederick Eisenbud, Suffolk County assistant district attorney, two of the pools received 10 million gallons of waste water containing toxic materials. State officials found trichloroethane concentrations as high as 81,000 parts per billion in one unlicensed pool. The permissible limit under state law is 50 ppb.

Circuitron "consciously and surreptitiously built cesspools under the building" and falsified monitoring records, according to Piaggione. The most serious charge in the 45-count indictment against Lombardo carries a maximum jail sentence of seven years and a $100,000 fine. Dwight Miller, an ADI official, says manufacturing continues at Circuitron as state and federal officials continue to monitor the pools. But no new pollutants are being added.

Miller adds that ADI is constructing a new plant that includes a $1.5 million waste treatment facility, which he says could be the best in the state. Using this facility, ADI will be able to recycle waste water as well as collect and reuse some metals and solvents. "Nothing [will be] going into the ground," he claims.

The recycling of waste water containing solvents and metals has increasingly become an economic expedient as disposal costs rise, explains Al Macklin, a DEC regional engineer for environmental quality. Macklin says Long Island industries have been encouraged to recycle wastes or precipitate metals out whenever possible for some time. Both Macklin and Piaggione say ADI's new plant represents a significant expenditure for a waste treatment and recycling facility.

A facilities manager at a large Long Island pc-board maker, who asked that he and his firm not be identified, says problems with waste disposal were seen as early as the mid-1950s. Now, he explains, his firm attempts to reuse as much of the waste material as possible. "Economy is what drives it," he acknowledges. A drag-out operation and an ion-exchange process recover waste gold from plating operations, and sludge is often sold to a recycler. He adds that attempts are being made to recycle solvents because disposal is costly. "Even etchants are now being recycled."

So far, 25,000 wells have been tested. Between 3% and 4% contain levels of synthetic organics above the 50-ppb threshold, explains Dr. Mahfoz Zaki, director of the Public Health Division of the Suffolk County Department of Health Services. Nevertheless, he says these solvents have been tested only during industrial exposure, making any assessment of toxicity to the general public difficult.

Moreover, Long Island officials and experts disagree about the overall seriousness of the current groundwater situation. Some state officials say the island's top glacial aquifer is completely polluted in some areas.

David Miller, a hydrogeologist and private consultant, believes there is a problem but adds, "We're far from a crisis, although it has been a crisis atmosphere." Still, Suffolk County health-department officials have proposed regulations for water pollution control in response to what they see as a growing problem with industrial pollution of groundwater supplies. –**George Leopold** use the study's results in making decisions that affect the environment.

Defining the problem is an irksome obstacle to attempts to correct health and environmental problems. "The most irritating thing of all is *that* we don't know how serious the problem is," says Glenn Roberts, legislative aide to U.S. Rep. Norman Mineta of San Jose. "We urge, encourage, and push various administrative agencies to expedite cleanups. We're trying to improve the laws so that [toxic leaks and spills] don't happen elsewhere."

Definition of health. There is disagreement about the severity of the toxic spills reported in Silicon Valley and the danger they pose to the drinking-water supply, and even about industry's promptness in cleaning them up. But no one disputes that dangerous chemicals have indeed leaked into the ground water, and that something must be done about it.

By contrast, the dispute over workers' health focuses on whether the industry has a poor health record. That, in turn, is based on definitions of illness as well as on how the statistics on health are listed and interpreted.

The debate centers on the definion of an occupational illness, which really translates as an OSHA-reportable illness. This means an incident that must be reported to the state Occupational Safety and Health Administration, a division of the Department of Industrial Relations.

Using statistics provided by the department for 1977 through 1980, LaDou, of the San Francisco Medical Center, tries to demonstrate that the semiconductor industry has an illness rate more than three times the manufacturing industry's in general. But the SIA, using figures from the U.S. Bureau of Labor Statistics, purports to show that semiconductor manufacturing was the third safest in the nation, ranking behind only the manufacture of missiles, space vehicles, and typewriters in 1982.

The source of all of the data is the same—OSHA reports filed by manufacturers after incidents of injury or illness. But California has not broken out separate figures for the semiconductor industry from overall electronics-industry reports since 1981, partly because of a change in the method of reporting and partly to skirmishing in the bureau, which resulted in a change in the size of the statistical data base. The upshot is that semiconductor-industry illness figures are buried in the admittedly low figures for injuries in the electronics industry, LaDou says.

Before 1981, incidents in which workers were exposed to toxic gas were reported as illnesses, according to bureau guidelines stating that cases resulting from one-time incidents were injuries and those resulting from prolonged exposure to a hazard were illnessess. All illnesses must be reported. However, injuries need not be reported unless they result in loss of consciousness, restriction of work, or medical treatment beyond first aid.

Semiconductor firms believed that occasional inhalations of gas that did not result in any symptoms were not illnesses. In 1981, acting on the advice of Dr. Donald Lassiter, a one-time federal OSHA official it had hired as a consultant, the industry started treating inhalation cases as injuries. Most of these did not require reporting, and the injury-plus-illness rate dropped dramatically.

Inhalations that resulted in no symptoms and no loss of work were more properly considered as exposures only. Thus they simply were not listed unless they caused loss of work, explains Lassiter.

LaDou says that using the new reporting system the companies can screen out inhalation incidents they consider trivial. Consequently, they skew the state's health and safety records. "No industry has ever done anything so clearly against the interests of its workers."

More support. Unable to track illnesses per se, LaDou has turned to statistics on lost work days and come up with more figures that he says support his case. For instance, in 1983—the last year for which bureau figures are available—occupational illness was responsible for 22.8% of all work-loss cases in the semiconductor industry in California. For industry as a whole, the figure was 7.2%, he reports.

Sees improvement. "There's no question that the situation is getting better," says Donald Dalke, an engineer with the state's San Francisco Regional Water Quality Control Board.

Part of this discrepancy may be because the industry has such a low injury rate, making the percentage of illness high. "I don't dispute Joe [LaDou]'s figures," Lassiter says. "We're using the same data, after all. But we [the SIA] see the same cases—why don't we see a high illness rate? Most of these cases are called 'systemic poisoning,' and the state can't even find the particular body system involved."

Lassiter now operates an industry injury/illness reporting system for the SIA that covers more than 100,000 workers in the industry. Participating companies—including most of the big ones—send their OSHA data to Lassiter, who cross-correlates it against job descriptions

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and provides detailed (and confidential) reports on how each company compares with the industry average. "It's like a share-of-market report," he notes wryly.

Lassiter and the SIA maintain that reporting exposures as illnesses would provide a false picture because it hasn't been proved that low-level exposure to toxic fumes is harmful. "There is no question it isn't proved. It has not been studied. But we have some very strange data for a 'non-problem' area," replies LaDou.

Responds Lassiter: "Based on what I see—which are the OSHA-reportable illness and injury figures—I think the semiconductor industry is one of the safest and healthiest in the United States."

Little medical study. Beyond some research in Scandinavia resulting in a generalized conclusion that long-term exposure to solvents causes an increased prevalence of neuropsychiatric illness, very little medical study has been done on the possible effects of long-term low-level exposure to toxic chemicals. Lassiter says that, in time, the detailed records he is keeping for the SIA can help pinpoint long-term effects.

LaDou suggests that a direct study of industry workers, such as a study of pregnant female workers on the fab lines, would reveal a lot about the effect on health of working with chemicals. It would cost $1 million, take two to three years, and would require the cooperation of several large companies.

According to Hinkelman, the SIA has funded a study something like that. But he won't reveal details, except to say that the study is being conducted independently at a university and that results will probably be available this year.

Dr. Linda Rudolph, an epidemiologist who worked on the California study of the Los Paseos water district (which was a victim of the Fairchild spill in San Jose), says that one proper follow-up of such a study would be a study of an increased-risk group, such as semiconductor workers. No such study has been announced, although the state has appropriated $625,000 for follow-ups.

In May, the SIA and the Semiconductor Research Corp. will sponsor a two-day workshop on the impact of hazardous semiconductor process technology on health and safety. LaDou acknowledges that the industry does seem to be responding to issues of health and environmental safety, but he remains skeptical of management's commitment.

LaDou is serving as general editor of a special issue of a quarterly medical journal devoted to health, safety, and environmental issues that arise from the use of chemicals in the semiconductor industry. The issue, called *Health in Electronics*, will be published in September.

He warns that the industry runs considerable legal risk if it does not take a greater interest in long-term illnesses and systemic effects. "I went to Sweden to talk with some of the people who have been studying toxic chemicals. In the waiting room I met some Americans. They were plaintiffs' lawyers."

Although the SIA concedes that past safety and environmental practices—which it defends as standard for all industry at the time—may have left something to be desired, the association insists that some of the current pressure on industry is a ruse to open the door for organized labor.

Unions are anathema to semiconductor manufacturers, who fear they would be made noncompetitive if their workers were organized. No semiconductor workforce is organized, and the companies maintain substantial voluntary programs of benefits.

"The toxic chemical problem is new," says the SIA president Hinkelman, a former executive with both Motorola Inc.'s Semiconductor Products Sector and Fairchild Camera & Instrument Corp. "It's very visible here [in Silicon Valley] because of

PC-BOARD GROUP DEFINES PROBLEM

The printed-circuit-board industry's trade association, the Institute for Interconnecting and Packaging Electronic Circuits (IPC), has been working with the Environmental Protection Agency to define permissible limits of toxic effluence. "Over the last 10 years, we've been active in interfacing with the EPA to come up with final regulations that make sense," says Raymond E. Pritchard, the IPC's executive director. But when the IPC filed a lawsuit aimed at easing the rules, it had to be dropped: the IPC couldn't find any companies that were willing to put their operations on the line to have effluents tested to produce data for the suit.

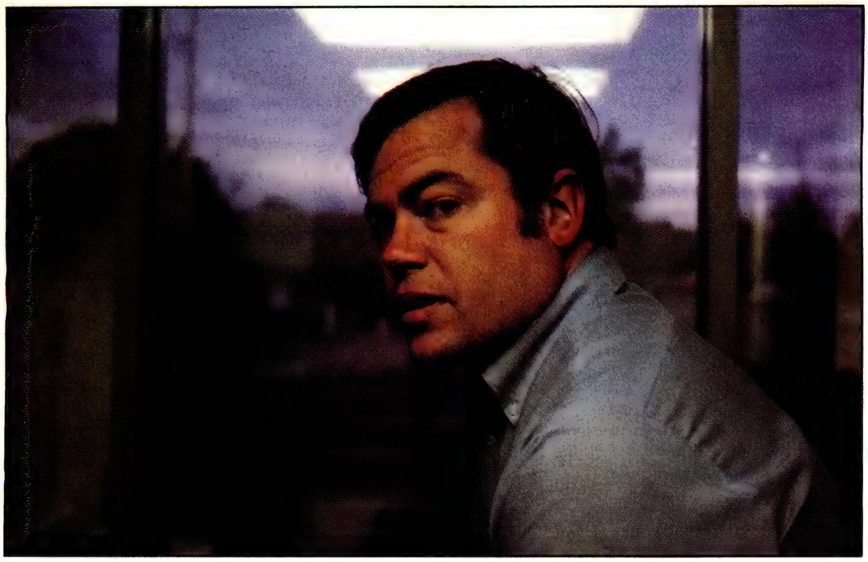
Nevertheless, Pritchard says, the issue has now settled down and final parts-per-million or -billion numbers on allowable limits for effluents have been pretty much established. Meanwhile, the *Chemical Safety Handbook*, put together by a special IPC task force, should be ready this fall. "The regulations are difficult, but they can be achieved—but with a lot of expense," Pritchard says, noting that some large firms, such as AT&T, have spent up to $2 million for equipment to control effluents.

On the one hand, Pritchard thinks that "representatives from our industry have really worked hard to comply with the regulations and we've worked with the EPA and spent a hell of a lot of dollars trying to cooperate." But at the same time, he indicates that enforcement and resulting compliance by the industry may be spotty at best. "This has been a very important issue for a long time, and it will become serious again if the federal government starts closing plants. But like a lot of things, nobody pays much attention until somebody starts shutting them down."

At present, pc-board makers can get off the hook by signing a document stating that their effluents don't contain offending levels of chemical residues and other harmful materials. But in at least some cases, problems could arise if enforcing agencies actually check up.

Besides the problem of effluents that are dumped into local sewer systems is the question of what to do with sludge, Pritchard says. As it stands now, "nobody wants anybody to dump anything anywhere," and so the material ends up getting carted around to sometimes distant dump sites. Another problem, he says, is that "dumps that have been getting this stuff for years are now more in the public eye."

–Wesley R. Iversen



Competitive. Intense competition among companies makes them reluctant to allocate resources to police the enivronment, says Ted Smith, head of the Toxics Coalition.

the concentration of industry—and the existence of an adversary group. Fixing the problem is insufficient because the adversary group has another agenda."

Singles out SCCOSH. The group he is talking about is SCCOSH, the nonprofit Santa Clara Center for Occupational Safety and Health, which he claims is raising health issues among workers so that others may organize them.

Founded in 1979 by Pat Lamborn, a former National Semiconductor Corp. assembler, SCCOSH is partly funded by the Santa Clara Central Labor Council and the Building Trades Council. The group originally enjoyed federal OSHA funding to carry on worker education about safe handling of toxic chemicals.

"This is the largest nonorganized industry in the United States and one of the fastest growing," the SIA's Hinkelman says of the semiconductor industry. "We have successfully maintained a nonunion environment as far as pay and benefits are concerned. Unions are now turning to the health issue because the others haven't been successful."

Hinkelman says he fully supports SCCOSH's right to accept union backing. But he complains that the group misrepresents the industry's efforts to improve safety and environmental protection.

He says that records kept by the SIA show the industry to be one of the healthiest and safest in the country. He also says that it has made major efforts to clean up toxic spills and to write codes and model ordinances that would prevent future incidents.

Lamborn responds that the industry drags its feet on safety measures and is ignoring dangers to health. "Our evidence indicates that people experience debilitating illnesses relating to chemical exposures, both acute and immediate, and chronic." The companies are not dealing with that issue, she says, but she concedes that the evidence is anecdotal. "I don't know if it's right—neither do they. It may apply to thousands of people."

SCCOSH charges that the electronics industry successfully petitioned President Reagan to get its OSHA funding cut in 1981. "They [chipmakers] think we're a pain in the neck," says SCCOSH aide Shirley Conrad. She is now organizing Silicon Valley workers who consider their health to be impaired by their occupations into a SCCOSH activity called the Disabled Workers United Group.

See pressure needed. SCCOSH's environmental arm is the Toxics Coalition, headed by attorney Ted Smith. Smith says that the highly competitive nature of the semiconductor industry makes companies reluctant to spend extra money on environmental protection. "There has to be some additional outside pressure to give them incentive."

Some of that pressure comes from Smith's wife, Amanda Hawkes, who is also an attorney. Hawkes has represented a number of workers against semiconductor firms about work-related issues. Neither Smith nor Hawkes sees any conflict of interest in the dual family role.

"The issues raised by the Toxics Coalition are important," Hawkes says. "I have the same interest in controlling hazardous wastes as anyone. In my work, I represent individual people who claim they have suffered harm."

At the same time, the industry has its own husband-wife team: Dianne McKenna, a member of the Santa Clara County Council and former mayor of Sunnyvale, home to dozens of semiconductor firms, and Regis P. McKenna, whose public-relations firm wrote an SIA position paper emphasizing industry achievements in safety and health and environmental protection.

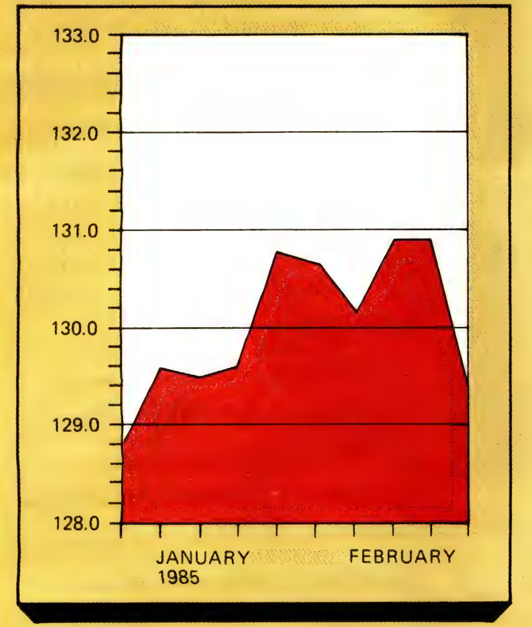
Regis McKenna sees no conflict here either. "I live in the heart of Silicon Valley myself, not up in the hills. I drink the water. I'm not interested in protecting the semiconductor companies—I'm interested in solving the problem."

In addition, he says, "There is plenty of blame to go around—semiconductor companies for allowing the problem to occur in the first place, local, state, and national governmental agencies for not acting on it sooner, and suppliers for not educating their customers on how to handle the chemicals."

Lawsuits feared. He explains that the companies are leery of getting together on the problem because they are afraid of lawsuits. "For six months, I've been trying to collect semiconductor executives and political representatives in a room where they won't feel threatened by what I say or do. There isn't an executive in the valley who doesn't want to solve the problem. But they're afraid to discuss it openly because of the threat of lawsuits." ☐

Reporting for this series was also provided by Eve Bennett and Denise Caruso in Palo Alto, Craig D. Rose in Boston, George Leopold in New York, J. Robert Lineback in Dallas, Wesley R. Iversen in Chicago, Larry Waller in Los Angeles, and Jon Joseph in Tokyo.

ElectronicsWeek Index



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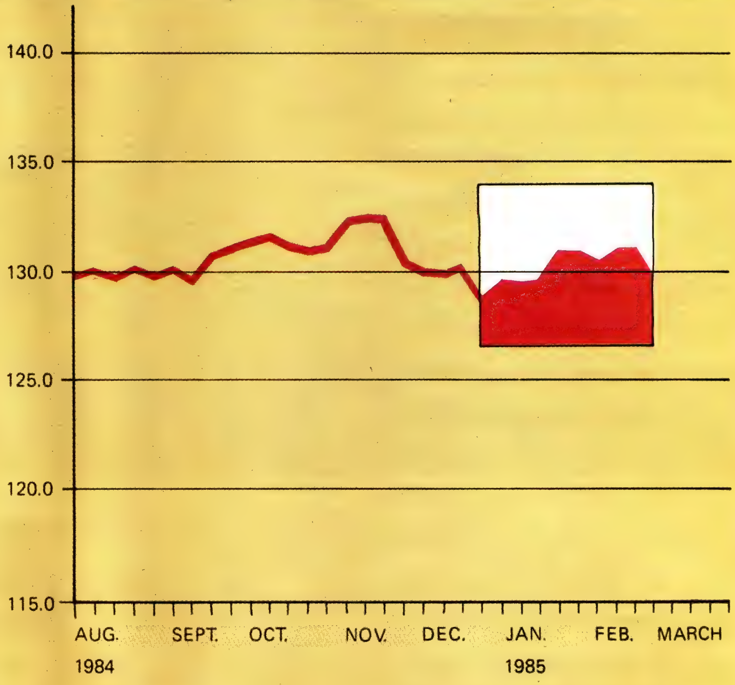
LAST WEEK = 130.9
YEAR AGO = 121.0
1982 = 100.0



The *ElectronicsWeek* Index, a seasonally adjusted measure of the U.S. electronics industry's health, is a weighted average of various indicators. Different indicators will appear from week to week.

U.S. ELECTRONICS INDUSTRY SHIPMENTS

Shipments ($ billions)	January 1985	December 1984	January 1984
Communications equipment	4.820	5.659	4.812
Radio and TV receiving equipment	0.979	0.876	0.758
Electronic and electrical instruments	4.838	4.819	4.568
Components	3.498	3.877	3.255

U.S. GENERAL ECONOMIC INDICATORS

	January 1985	December 1984	January 1984
Index of leading economic indicators	166.7	163.9	163.4
Budgeted outlays of the federal government ($ billions)	76.838	77.583	74.705
Budgeted outlays of the Department of Defense ($ billions)	19.367	20.156	19.576
Operating rate of all industries (% capacity)	80.0	79.8	78.6
Industrial-production index	166.6	165.9	156.2
Total housing starts (annual rate in thousands)	1,833	1,595	1,704

A precipitous decline in shipments of communications equipment in January pushed the *ElectronicsWeek* Index down 1.2% in the current week to its lowest point since the beginning of August. Communications equipment, with shipments down over 7%, is the most recent equipment category to be affected by the increased wave of imported electronics gear. Other types of electronics goods fared better. Shipments of radio and TV equipment surged almost 12%, while instruments inched up as well.

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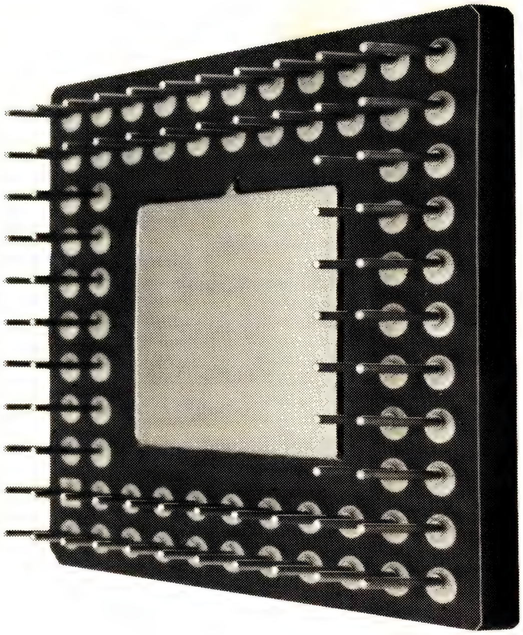

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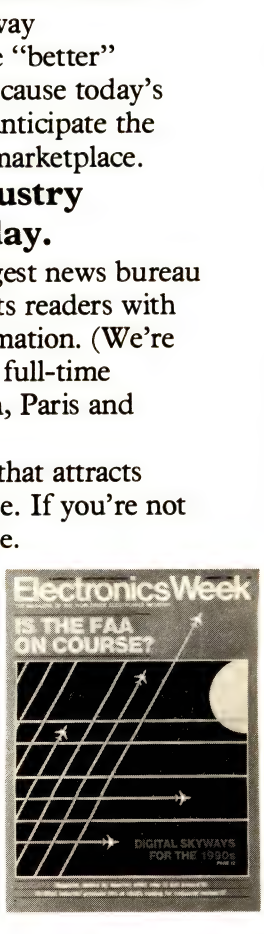


FROM NEURONS TO TRANSISTORS, HILLIS THINKS IN PARALLEL

Cambridge, Mass.

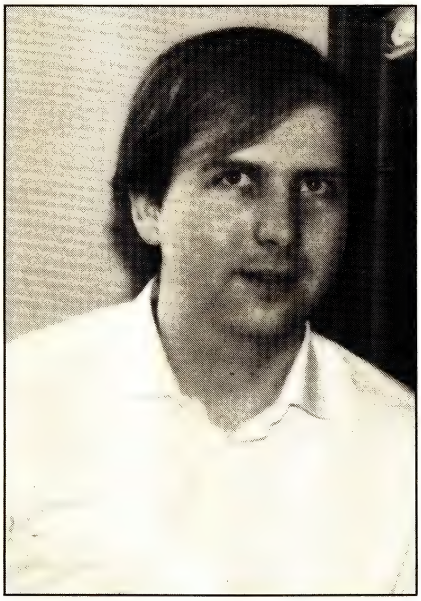
When Danny Hillis casually remarked once that he drives to work in a fire engine, the next question was automatic: Where did you get the fire engine? "Oh, I traded in my other fire engine for it," Hillis answered with a grin.

If that sounds whimsical, Hillis also asserts that the company he cofounded two years ago, Thinking Machines Corp., will produce by the end of this year a non-von-Neumann computer linking 64,000 processors in a highly parallel architecture. No whimsy here, though, because the prototype, called the Connection Machine, will be delivered to the Defense Advanced Research Projects Agency.

All-star team. At Thinking Machines, Hillis works with an all-star list of founding scientists that includes renowned Massachusetts Institute of Technology professor Marvin Minsky. Another key member of his team is Marvin Denicoff, who was director of artificial-intelligence research at the Office of Naval Research. But principal credit for the Connection Machine's architecture goes to the 28-year-old Hillis. Born in Baltimore and raised in the Southwest, he arrived at MIT 11 years ago to study neurophysiology.

A career probing neurons seemed the ideal way to probe the secrets of the brain, which Hillis finds "the most exciting mystery left in science." Yet soon after arriving at MIT, Hillis found he was more interested in the goings on in Minsky's AI laboratory.

"It was the golden age of artificial intelligence," he says. "People were just realizing how much was possible—but didn't realize how hard it would be to get there." Those difficulties arose when scientists tried to scale up the promising experiments of the day and quickly ran up against the limits of their computers.



The thinker. Danny Hillis applied his knowledge of the human brain to his highly parallel design for the Connection Machine.

As scientists at MIT sought to stretch those limits, Hillis found his background in physiology helped. "It was pretty obvious to me that our fundamental problem was not that the transistors weren't fast enough, because the transistors, of course, are much faster than neurons. Somehow the brain manages to do all its work using switching components that take milliseconds to switch." Noting the nanosecond switching speed of transistors, he decided that the way they were organized was the key.

Despite the speed advantage of transistors over neurons, however, they were not fast enough to solve the difficulties in AI experimentation. Increases on the order of ten-thousandfold were needed. So Hillis directed his work toward developing a machine with a high degree of parallelism.

This approach presented massive problems of its own, most obviously how to connect all those processors. The project began at MIT, but soon Hillis and others working on it decided to raise venture capital and start Thinking Machines. The move "allowed us to get industrial-strength talent." He decided that they couldn't develop and produce the Connection Machine using the resources and people at MIT alone. In addition, by working privately, Hillis has the opportunity to make a profit on his work.

Hillis says the 64,000-processor machine being built is a steppingstone to a million-element model. "We're still talking small potatoes compared to the brain, which is more like 10 billion neurons operating in parallel. But our [processors] are faster." –**Craig D. Rose**

SCHNEIDER HEADS SPERRY'S SUPERCONDUCTIVITY PUSH

St. Paul, Minn.

I can't remember a time when there's been so much world-class, really compelling technology demonstrated that has not led to product."

This statement from Raymond J. Schneider Jr. addresses a topic—superconductive Josephson-junction devices—that is dear to his professional heart [*ElectronicsWeek*, Feb. 25, 1985, p. 28]. Last month, the 42-year-old Schneider was named director of Sperry Corp.'s Corporate Technology Center in charge of Josephson-junction research, following six years as technical chief heading that research for the Defense Products Group. With some 24 researchers and annual company funding of more than $2 million, the Sperry push headed by Schneider is one of the largest commitments by a U.S. industrial firm to do research into this technology.

In charge. Head of Josephson-junction research for Sperry, Raymond J. Schneider says the technology will soon be marketable.

Although Schneider had never worked with Josephson junctions before he joined Sperry in 1977, his work in sensor technology at the Naval Air Development Center, in Warminster, Pa., showed him how superconductive electronics could bring potentially spectacular performance enhancements to magnetic sensing. During a 15-year stint there, beginning as a student trainee during the summer, Schneider worked as a section head in magnetic detection technologies. He notes that his work at the center also helped him better understand problems in deploying the superconductive technology.

Well understood. "It's ironic that superconductivity is extremely well understood," says Schneider, who has a bachelor's degree in physics from Philadelphia's Saint Joseph's University and a master's degree in engineering science from Pennsylvania State University. "There is a very significant design technology that is available in Josephson devices." But except for a few sensor devices sold commercially for geomagnetic exploration, biomedical research, and other niche applications, commercial and military products have yet to emerge from the lab.

Schneider thinks that, "given the right investment climate," significant devices using Josephson junction technology could be ready in three years. **–Wesley R. Iversen**

YOSHIDA SEEKS YANKEE INGENUITY FOR JOINT VENTURES WITH TOKYO ELECTRON

Tokyo

After working for 7½ years as a transformer designer with a large manufacturer in Osaka, Minoru Yoshida knew that he belonged in a small firm. So in 1968, he started over at the bottom with Tokyo Electron Ltd.

Yoshida joined Tokyo Electron because it was a relatively small firm with good prospects—more important to him than the type of work he would be doing. Now, 17 years later, the company is Japan's leading importer of U.S.-made semiconductor-production equipment, and Yoshida, 48, is its president [*ElectronicsWeek*, Nov. 5, 1984, p. 56].

His first assignment was to open an office in Osaka for handling trouble calls on semiconductor-production equipment, which tended to be unreliable. Unfamiliar with the machines, but a self-described very hard worker, he learned from customers and from studying manuals before and after work.

Import leader. Minuro Yoshida's company is now Japan's leading importer of U.S.-made semiconductor-production equipment.

His efforts paid off. Through his newly acquired knowledge of the machines, Yoshida was able to provide faster service. But he still faced an internal problem with his company, which was slow in delivering parts to customers.

Searching for a solution, he urged customers to consider buying backup machines as one way for them to acquire more flexibility and as a way to get his firm to respond faster to service requests. The tactic worked: he found that his firm would respond quickly to service requests if customers also gave purchase-plan information.

Riding shotgun. A promotion returned Yoshida to Tokyo, where he had to generate sales for a U.S. manufacturer whose customers weren't coming back because of the poor reliability of its equipment. To tackle this problem, he persuaded the manufacturer to send an engineer to Japan to make repairs, while he went along on the engineer's calls as driver, translator, and salesman. This kind of help impressed his customers, who then saw greater value in the equipment Yoshida was selling.

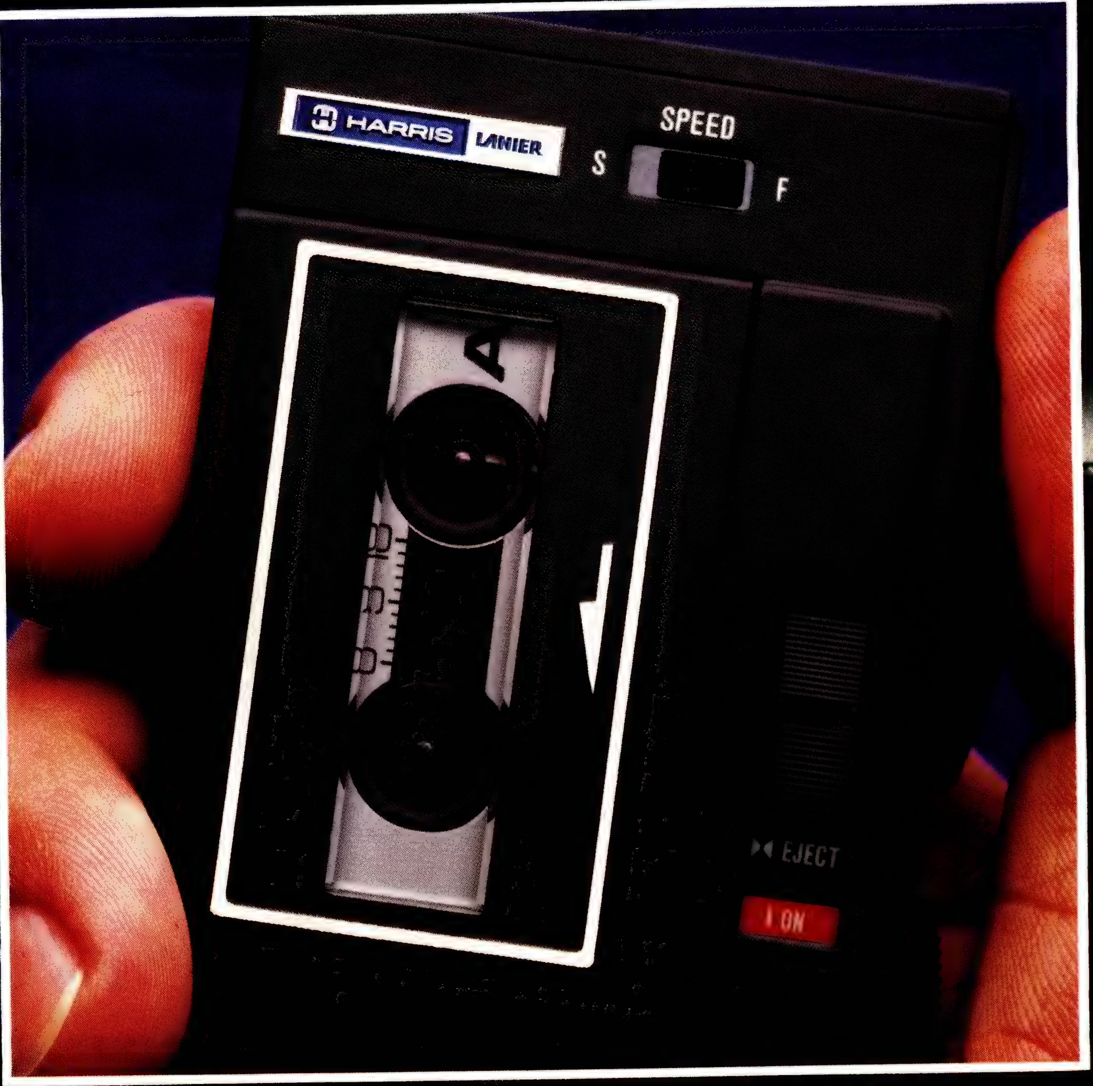
By 1973, Yoshida was a manager for Tokyo Electron on the lookout for new business. He correctly forecast the need for computer-aided design in the semiconductor industry and decided that, as a specialist in importing U.S. semiconductor-production machinery, his firm should seek a CAD vendor. Yoshida went to the headquarters of Computervision Corp. and persuaded it to appoint Tokyo Electron as its exclusive agent in Japan.

Tokyo Electron's biggest single account is now Varian Semiconductor Equipment Corp., which Yoshida added to the lineup in 1978 after he had become a managing director.

Yoshida wants to sell more products developed by what he terms "U.S. originality." In order to do this, he says joint-venture production in Japan is sometimes needed—even though it isn't always very profitable. Joint ventures develop and produce products suited for the Japanese market, he says, "preventing domestic competitors from finding a gap in the product line in which they can establish a beachhead and then wrest away the market by selling at lower prices." **–Charles L. Cohen**

"JUST WHEN I GET A GREAT IDEA, THE DICTATING MACHINE BREAKS!"

Lanier, 1984



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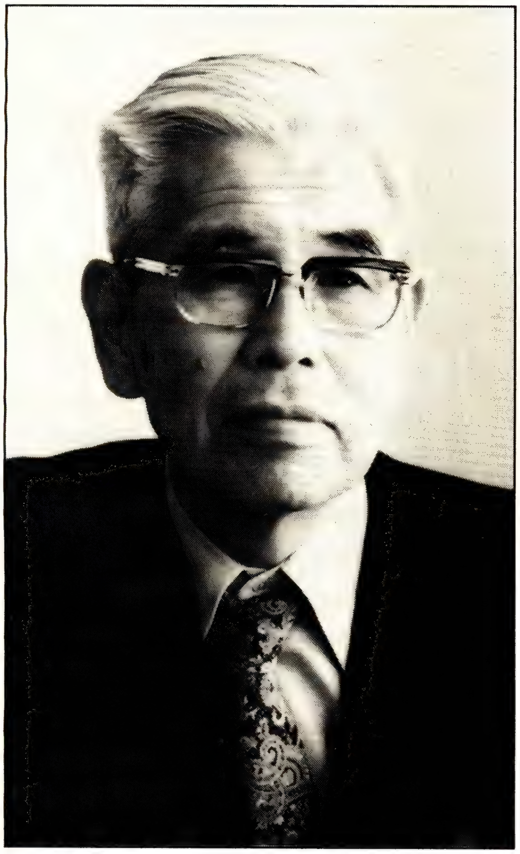
SHIN-ETSU HANDOTAI RAMPS UP FOR COMING SEMICONDUCTOR REVIVAL



Optimistic. "This is a period of supply and demand adjustment, not stagnation," declares Shin-Etsu Handotai president Kihachi Tamura about the depressed world semiconductor market.

Tokyo

At a time when many of his competitors are revising their business plans in the face of another semiconductor market slump, Kihachi Tamura is pushing full speed ahead. This month, the U.S. subsidiary of Shin-Etsu Handotai Co. will open a $32 million expansion facility at a wafer-fabrication plant in Vancouver, Wash., and next month, Tamura's European division will go into full fabrication of wafers at another new plant, a $4 million facility near Edinburgh, Scotland.

"Why?" Tamura, Shin-Etsu Handotai's president, asks rhetorically. "Because we're in an 'aircraft industry.' We must keep spending, or we'll crash and die."

Tamura is strongly optimistic about the overall semiconductor market. "This is a period of supply and demand adjustment, not stagnation," he declares.

"We're in a position to see ahead of the market, because when the semiconductor makers see trouble, they cut back on wafer orders first," the executive notes. "Our shipments to the U.S. peaked last October, then slumped severely in November and December, but our February shipments recovered close to the October level and I expect a turnaround by late spring."

The position and strategy of Shin-Etsu Handotai in worldwide semiconductors are not quite as vulnerable as Tamura indicates. The company was established in 1967 as the electronics arm of a major Japanese chemical maker, Shin-Etsu Chemical Corp. (*handotai* is the Japanese word for semiconductor). The deal was a joint venture with Dow Corning Corp., but in 1979, Shin-Etsu Handotai bought out Dow and went on to claim a 45% share of the Japanese wafer market, and a 25% share of the total world market.

Flat domestic sales. Total sales last year were an impressive $367 million, a sizable jump over 1983's $247 million. But with domestic sales flatter in recent years because of competition from such rivals as Mitsubishi Metal Corp. and Osaka Titanium Co., Tamura sees foreign markets playing a greater role in his firm's future.

SEH America Inc., Shin-Etsu's U.S. subsidiary, has an estimated 12% to 15% share in a U.S. wafer market worth close to $700 million annually. "I want to double that share," says the engineer-turned-president, and he predicts that epitaxial wafer-based CMOS products will be the largest-growing segment of the U.S. market.

Shin-Etsu's new Vancouver plant will be both its first epitaxial-wafer production facility overseas, and the first such plant for a Japanese maker. "We'll also be closer to our customers," Tamura says. "We'll cut transportation costs [all epitaxial materials are now imported from Japan], and we'll have a firm base for expansion," he points out.

Among SEH America's new customers might well be NEC Corp., which opened a very-large-scale-semiconductor plant in Roseville, Calif., last year; and Fujitsu Ltd., which plans a similar facility in Oregon by 1986.

The subsidiary's original Vancouver plant was opened in 1981 at a cost of $40 million and employs 650 people. With the addition of the new fab plant and its Class 1000 clean room, the workforce will increase to 800. An additional 20 engineers have been transferred from Japan to oversee operations.

Offshore expansion. Shin-Etsu Handotai's offshore business began in 1974, when a plant in Malaysia began producing polished wafers. In Japan, the company now has three silicon-crystal plants and three affiliated wafer-processing plants. The new Scotland plant, Tamura says, will produce floating-zone single-crystal wafers for the high-power rectifiers and direct-power transmission devices that are used primarily in the European market.

Shin-Etsu Handotai, which has doubled its staff of research engineers in the last three years, spends roughly 10% of its profits on research and development, Tamura says. The company's next target is hardly a secret: Shin-Etsu Handotai

Growing. Shin-Etsu Handotai, with a 45% share of the Japanese wafer market and 12% to 15% of the U.S. market, now holds a 25% share of the world's total wafer market.

installed a new domestic fabrication line for 6-in. wafers last year and the organization is now ready for full-scale production.

"Everyone is trying to develop a perfect single-crystal wafer with an 8-in. diameter," Tamura says. But even if such a product did exist, "the market just isn't there yet," he points out.

The market that does exist, he notes, is for wafers with diameters of 5 or 6 in., which accounted for just 30% of total worldwide demand two years ago, according to Tamura. However, these wafers grew to 60% of total world demand by the end of 1984. – **Michael Berger**

JAPANESE FIRM'S UNIT IN THE U.S. SEES IMPORTANCE OF LOCAL PRODUCTION

Sunnyvale, Calif.

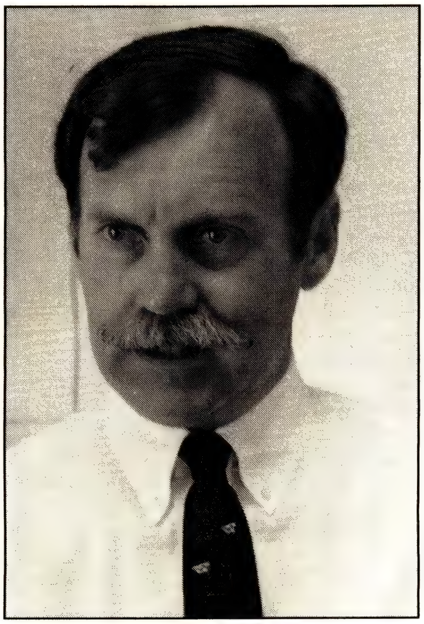
Born out of the desire by Japan's Oki Electric Corp. for a base in the U.S., Oki Semiconductor has spent its adolescent years combining U.S. semiconductor design expertise with the manufacturing ability of its Japanese parent for high-volume products such as memory and communications chips.

However, as Oki Semiconductor looks to the future, in which the market for application-specific integrated circuits is projected to make up 40% of the total worldwide market by 1990, it has reached an important conclusion: it needs a stateside fabrication facility.

Fast turnaround. Application-specific ICs need to be made locally to ensure a very fast turnaround time, notes Oki Semiconductor president and chief executive Jerry Crowley. Japanese fab lines are "steel mill" type facilities, he says, that are unsuited to making application-specific IC products, which require finer product differentiation and finishing.

In line with this, Oki plans to build a fabrication plant in the U.S. No specific site has been chosen as yet. The firm hopes to have the test and assembly operations up and running by late this year. Currently, all of Oki Semiconductor's designs are transmitted by satellite link to the Japanese foundries of Oki Electric.

Crowley also believes Oki Semiconductor holds the key to success with its eight years of experience in transferring U.S. designs to remote manufacturing sites in Japan. "The leverage is in the software connecting the designer with the fab facility," he says.



Requirement. Application-specific ICs must be made locally to ensure a fast turnaround, says Oki Semiconductor head Jerry Crowley.

The move into application-specific ICs may have been facilitated by the distance—both physical and operational—between the two firms. The organization's East/West character has made a difference in its market stance.

Free to compete. "They are following along the path of most Japanese memory companies, but they are a little more aggressive than most Japanese companies that have been in place for several years," notes market analyst Mary Wu of Gnostic Concepts Inc. "They're out to be a merchant market [company] . . . that differs from the Fujitsus and NECs of the world. In that sense, they're free to produce what's needed in the marketplace . . . free to compete."

Founded by Crowley on $200,000 advanced by Oki Electric in 1977, Oki Semiconductor now has $25 million in assets and no debt. Crowley thinks sales will grow from last year's total of $140 million to about $1 billion by 1990. That amount would make his group responsible for one quarter of all Oki Electric's expected sales by then.

"Our process technology is driven by our memory products," says marketing director Leonard A. Distaso. Even so, Oki's products range from speech-synthesis chips to microprocessors. The designs that have been relegated to Japan's foundries are primarily very large-scale ICs—mostly CMOS—with memories accounting for between 50% and 60% of the output.

Oki introduced its most recent 64-K circuit as an end-of-the-line product. The 3764A, produced on a new 2-μm fab line, is expected to have a three-year volume-production life cycle, which is scheduled to begin in April. A major use of the product will be in Oki's 128-K memory, which stacks two of the 64-K chips onto a single 16-pin socket.

The 128-K memory, a version of which has been used in IBM Corp.'s Personal Computer AT for the past eight months, is an interim measure until 256-K chips come into widespread use. Oki has just introduced a 256-K chip. –**Eve Bennett**

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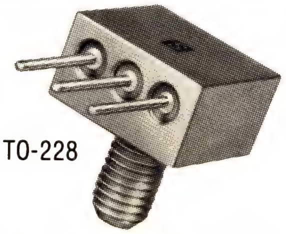

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SWITCHES TAKE TO OPTICS

Using optical and optoelectronic technology instead of electronic switches provides an option for switching-system designers ☐ *by Stewart D. Personick*

Fiber optics has emerged from the research environment to become the technology of choice for many information-transmission systems, including telecommunications circuits among telephone central offices and transporting data among computers in point-to-point connections and local-area networks. In the future, optical fibers will increasingly be used to connect telephone end users to their central offices and also for short point-to-point connections within electronic equipment. The growing use of optical and optoelectronic technology for transmission points to possible uses in switching, including both routing and multiplexing.

To construct photonic switching systems that use optical components to route information, it is necessary to understand the characteristics of the basic components. The key component in these systems is the optical crosspoint, a device with which an incoming optical signal can be routed to one or more of several outgoing paths. This routing is accomplished in several ways.

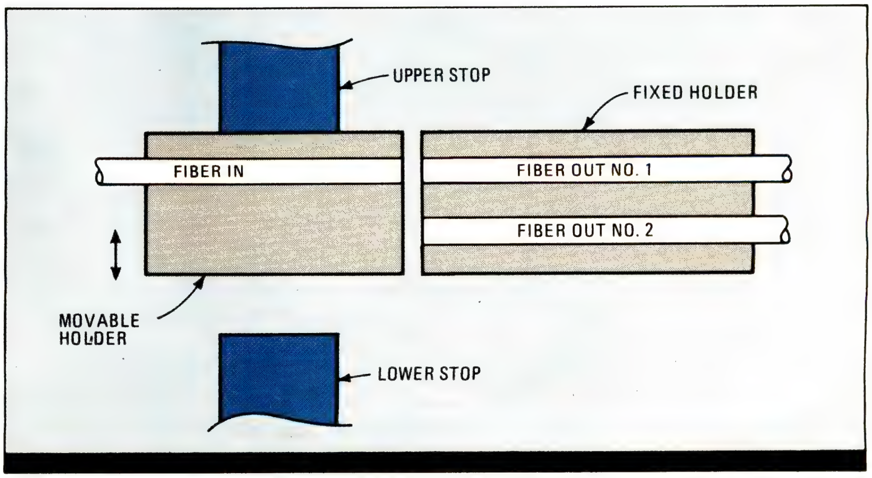
The mechanical optical-switching crosspoint uses a mechanical force to move an incoming fiber to one of two positions, thus coupling it to one of two outgoing fibers (Fig. 1). This mechanical force can be generated by an electrically activated solenoid. It is not necessary, however, to use a mechanically activated part to switch an optical signal between several points.

An electrically activated optical switch, which works on the principles of the electro-optic effect, can also be used (Fig. 2). This switch makes use of a substrate whose optical properties can be modified by the application of an electric field. The refractive index of the material can be modified slightly by the presence of a field produced between two electrodes when a voltage is applied to them. In the surface of this substrate, regions with a higher index of refraction (optical density) are formed by an ion-exchange process.

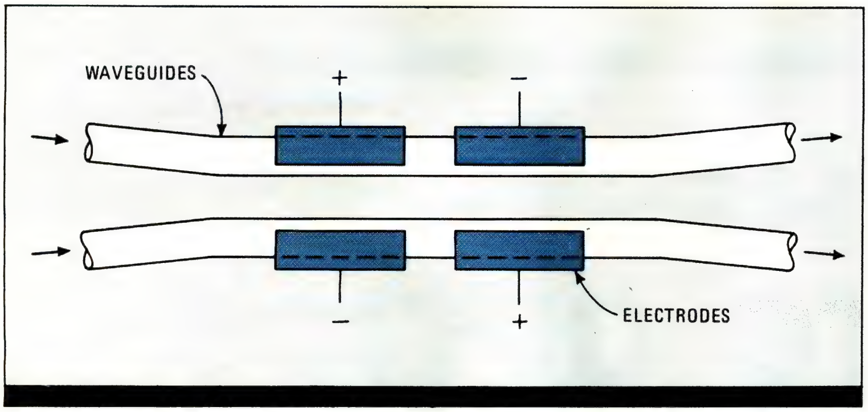
If the substrate material is lithium niobate, for example, regions of higher refractive index can be formed in the surface by exposure to titanium atoms. Making these regions into two parallel channels a few microns wide and a micron deep in the substrate's surface will form a pair of optical waveguides. Furthermore, if the two channels are close together, light guided in one channel can couple across to the other channel through a resonant coupled-waveguide process. How much coupling takes place depends on the details of the waveguides.

By using two sets of metal electrodes formed on the surface of the substrate above the waveguides, voltages can be applied to produce fields within the substrate; these in turn can control the coupling between the waveguides. With the proper design, it is possible to have nearly complete coupling or no coupling, thereby producing a voltage-controlled 2-by-2 optical switch. While these switches have shown steady progress toward practical application, they are still considered to be in an exploratory state of development.

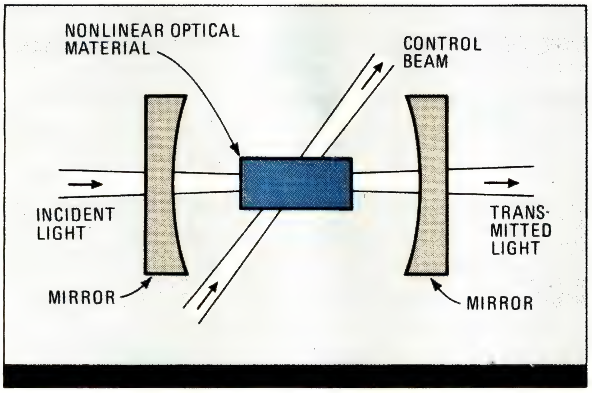
An even more elaborate method of implementing an



1. Fiber in, fiber out. The moving fiber switch is a mechanically operated switch that physically moves a fiber so that the incoming signal is switched to one of two outgoing fibers. The moving fiber may be operated remotely by means of a solenoid.



2. Electro-optic switch. Electro-optic switches use electro-optically active materials, whose characteristics can be changed by applying an electric field. This makes it possible to control the coupling from one wavelength to the other.



3. Optically activated. In this optical switch, two nearly totally reflecting mirrors are placed back to back in the optical path. The effective spacing between the mirrors is related to the wavelength of light through the path and determines whether the optical path is on or off. A control light beam determines the spacing.

optical switching crosspoint is with an optically activated switch, in which an optical control signal causes the transmitted signal to switch between two paths (Fig. 3). In this scheme, an optical cavity is formed by placing two nearly totally reflecting mirrors back to back. If the spacing between the mirrors is such that it is in precisely the correct ratio to the wavelength of light in the optical path—that is, in an even number of quarter wavelengths—then the combination of the two mirrors (one behind the other) will act as a transparent window.

This can happen because a large light field builds up inside the cavity formed by the two mirrors. Light leaking through the mirrors from this stored field cancels the reflection, and produces a transmitted signal in the direction of the incoming light. On the other hand, if the mirrors are an odd number of quarter wavelengths apart, the combination acts as a reflecting device. Therefore, the switching assembly can be changed from the transparent to the reflecting mode of operation by changing the apparent spacing of the mirrors.

This is accomplished by placing an optically nonlinear material between the mirrors. When the nonlinear material's optical density is changed by the presence of an optical field, the length of the gap between the mirrors is changed. Optically controlled optical switches based on nonlinear effects have been demonstrated in the laboratory, but they too are considered to be in the developmental stage. Nevertheless, they hold the possibility of extremely fast switching speeds—less than 1 ps.

Although optical crosspoints are the key parts of any switching system for optical signals, they alone are usually not sufficient. A number of electrically activated optical switches can be formed in the surface of an electro-optic material to form a simple 4-by-4 switch (Fig. 4). Any input can be switched to any output by applying appropriate control voltages to the electrodes above the individual 2-by-2 crosspoints. This forms a blocking switch, so all inputs cannot simultaneously reach all outputs. Also, as a light signal passes from an input to an output through the sequence of paths and 2-by-2 crosspoints, it degrades as a result of light attenuation caused by absorption, radiation, and crosstalk due to incomplete switching and light scattering.

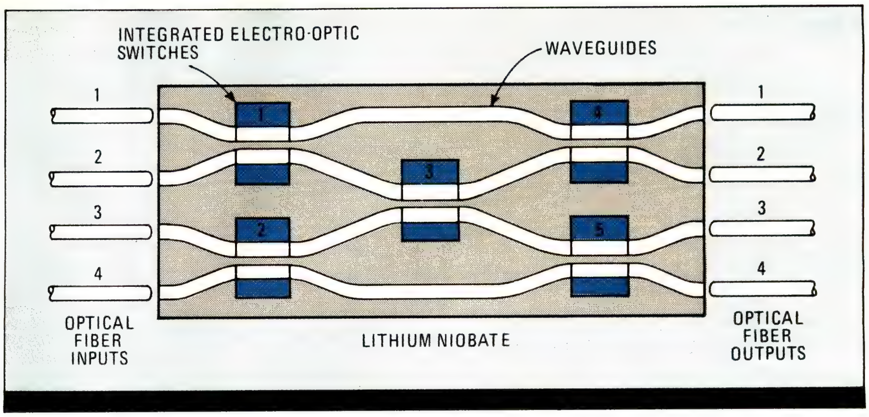
In electrical switching systems, the accumulation of loss and interference can be removed by amplifiers and regenerators. For an all-optical switching system with many inputs and outputs, the optical equivalents of electrical gain and regeneration may be necessary. Systems that provide such functions have been demonstrated in the lab.

Crosspoints typically allow one or two optical signals each to be directed to one of two outgoing paths. These basic crosspoints can also be used to construct switching systems for use in three different applications. The first is an automated optical cross-connect system that routes several inputs individually to many outputs to reconfigure a small optical network. The second is an optical circuit switch where a large number of inputs and outputs are interconnected to route calls of various types in a telephone network. The third uses very fast photonic switches to multiplex or demultiplex optical bit streams in order to configure novel switching and routing systems that take advantage of the unique attributes of optical technology.

Building a small switching system

A small n-input/n-output switching system can be built up from 2-by-2 basic crosspoints (Fig. 4). Several electro-optic devices can be integrated monolithically on a common substrate, but it is also possible to construct similar arrays by cascading individual crosspoints interconnected by optical fibers. Because of the accumulation of loss and crosstalk, such an approach to implementing a multi-input/multi-output switching array is limited to a small number of inputs and outputs. However, it is practical to construct switching arrays of this sort with mechanical switches as large as eight in/eight out and with integrated optical switching arrays as large as four in/four out (where all four inputs can simultaneously reach any different output).

Rearranging the connection patterns can be accomplished automatically without optical switches. For applications that require rearranging the connections of a



4. Optical switching array. By utilizing several 2-by-2 optical switches, a 4-by-4 array can be formed. The optical signal is controlled so that it either passes along the waveguide or couples to the adjacent waveguide, enabling any input to reach any output.

modest number of incoming and outgoing fibers that meet in a common place—for instance, at a switching hub—then a small electrically controllable optical-switching array may be suitable. Each incoming and outgoing optical fiber must terminate on an electrical-to-optical converter. The converter provides electrical signals to a conventional electronic switching matrix implemented with electronic crosspoints or metallic relays. The electrical-to-optical converters perform regeneration, but if the fibers are short enough, this function is not needed.

Thus without an optical switching array we incur the cost and complexity of the electrical-to-optical converters for no other reason but to interface to a conventional metallic relay or electronic switching array. Furthermore, these electrical-to-optical converters work at a specific wavelength—and often at a specific data rate of optical modulation—that constrains the end users.

A small optical switching array can simplify the interface by eliminating optical-to-electronic converters. It is important to keep in mind, however, that the optical switching array directs all of the information arriving on a given optical input to a chosen optical output. That is, the paths through the array are changed from time to time at the request of the network-configuration controller, but different optical pulses in the same optical stream are not directed to different outputs.

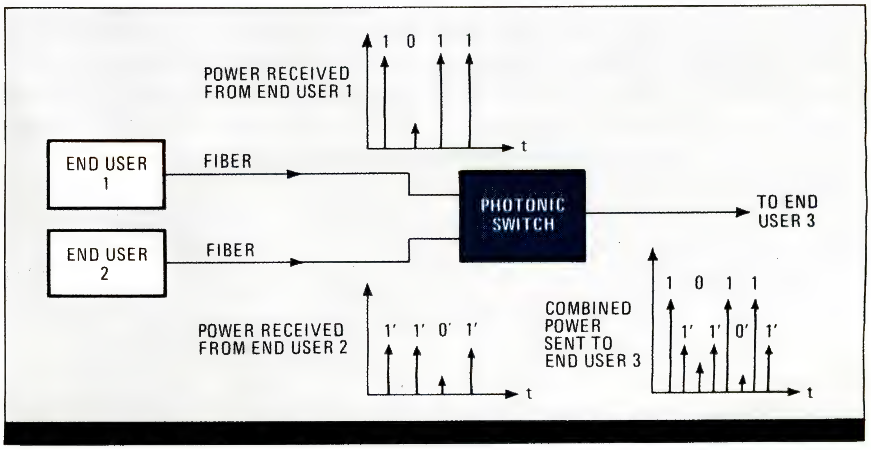
Because this configuration of an optical cross-connect system is assumed to change relatively slowly, it can be implemented with mechanically activated switches that contain electrically activated solenoids. Since mechanically activated switches represent a fairly well-developed technology, modest-sized mechanical cross-connect arrays can be configured for near-term applications.

At first, telephone switching appears similar to the automated cross-connect application described above. However, there are three important differences. First, the number of circuits terminating on a telecommunications circuit switch typically number at least in the hundreds, and often thousands; there may even be hundreds of thousands for large circuit switches. Because of the large numbers of inputs and outputs, the problems of loss accumulation and crosstalk would rapidly arise if the switching functions were attempted with an all-optical array. Use of regeneration could compensate for these effects. If the regenerators are implemented by converting the optical signals to electrical form, then it is possible to do the switching electronically.

Because the circuits being switched are modulated at speeds within the capabilities of electronic crosspoints—which are smaller and more highly developed than optical crosspoints—there is no reason to do the switching optically once there are optical-to-electronic conversions used for other functions, such as regeneration. To justify the use of optical switching it would be necessary to either do the regeneration function with exotic optical technology, or substantially modify the architecture of the switch or of the entire network.

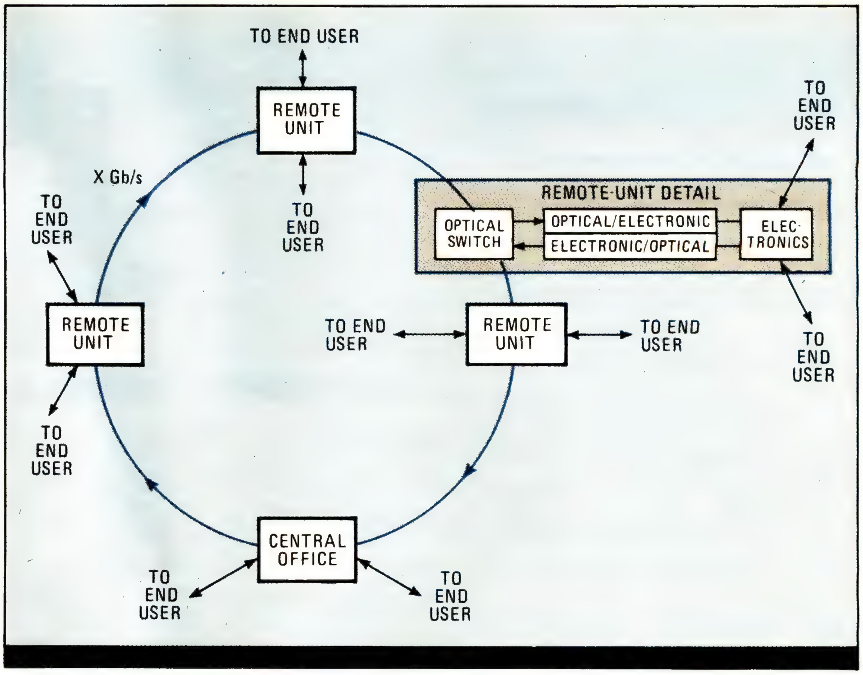
Even with all-optical switching and regeneration, the optical switching system would still have to compete economically with its electronic counterpart. Thus even though it appears at first that signals arriving on optical fibers might be most economically switched in optical form, this may not be the case.

Another difference between a telecommunications circuit switch and a cross-connect arises from the requirement to demultiplex and separately route multiplexed services. All optical signals arriving at any input in the cross-connect application were routed to the selected output. In a telecommunications switching application, it is likely that the arriving optical signal will be carrying many time-division-multiplexed information signals, which must be routed to different places. In conventional electronic switching, the optical signal is converted to electrical form and demultiplexed electronically. Because



5. Combining signals. Streams of pulses from two optical fibers can be combined to go to the same outgoing fiber. Bit-by-bit switching from two end users is used in the photonic switch to combine the two signals into one, for transmission to the third end user.

6. Ring me up. A ring network is another means of using optical switching. Remote units are connected to the end users by electronic means, and the signals are then transmitted around the ring optically. The central office simplifies access to the ring.



of this, the signals might just as well be switched electronically. Hence, an entirely optical telecommunications circuit switch will have to perform the demultiplexing function by optical means.

This can be done by synchronizing the switches' operation with the incoming optical pulse streams to route different pulses to different paths. Streams of pulses arriving on two optical fibers can be routed to the same outgoing fiber by this method (Fig. 5). To do this effectively, the optical power levels of the various pulse streams must be equalized so that they will be of comparable power when interleaved. Not only will optical switching be required but also optical gain, and it may be necessary to adjust the phase and timing of the incoming streams.

A third contrast is the rate at which the switching array must be reconfigured. In the telecommunications-circuit switch, paths must be set up in milliseconds or less to route calls. With a cross-connect, the configuration may not be changed very often and the time allowed may be long, so that the use of mechanical techniques may be inappropriate for modern switches.

It is by no means clear that an all-optical equivalent of today's circuit-switching systems is feasible, or even desirable. However, just as transistor technology is most effectively applied not as a substitute for vacuum tubes but in entirely new subsystem configurations, it may be that the best application of photonic switching technology in telecommunications-circuit switching will require changes in the architecture of networks.

Speed versus cost

The unique characteristic of advanced forms of photonic switching and optical fiber technology in general is that speed (and correspondingly, bandwidth) are incrementally almost cost-free—that is, their cost is insensitive to the rates at which they are used. This is in sharp contrast to conventional media such as metallic cable, radio, and electronics, where bandwidth and speed are at a premium. Thus, while in the past we have used functional complexity in terminal equipment to save bandwidth and to reduce circuit clock rates, with optical technology we may have to do just the opposite, since these devices are large compared to electronic devices (they must be at least several wavelengths in size).

Optical switching technology may be used in a ring network (Fig. 6). Remote units terminate signals from local customers, who access these units with fibers, wires, or other means. The information from these remote units is interfaced and multiplexed into a composite signal, which is then multiplexed onto a fiber-optic superhighway operating perhaps at multigigabit rates using optical switching devices. The optical switch either adds or drops (diverts) pulses of optical energy to the optical stream circulating on the fiber ring by changing its configuration in synchronism with the circulating stream.

The composite of all information arrives at a central node, where it is rearranged by a large cross-connect system to simplify access to the ring by the remote nodes. Thus, all circuits between remote nodes pass through the central node regardless of their origination and destination positions on the ring. This approach simplifies the access by each remote node to the ring because it does not have to place optical pulses destined for various other nodes in time slots associated with those specific destination nodes. All information is placed by an originating node in an easily accessible fixed set of time slots. The central node then moves the information, by means of its cross-connect function, to the appropriate outgoing timeslots that are being accessed by the various destination nodes. Thus, access to the ring is simplified at the expense of minimum-distance routing. However, since bandwidth is incrementally nearly cost-free, complexity is in fact traded against bandwidth.

Several rings can exchange information using a gateway implemented with optical switching technology. In order to make sure that there is an available time slot on the receiving ring to accept an optical pulse being diverted from a sending ring, it may require a great deal of extra bandwidth, or bit rate, in the receiving ring. However, this use of low-cost bandwidth saves the cost of storage, which would be otherwise required at the gateway to hold information waiting for an empty time slot. The use of excess bandwidth to save storage is exactly opposite to the conventional tradeoff, where bandwidth is costly and storage is relatively cheap. ☐

Stewart D. Personick is division manager, Transwitching Technology Research Division, Bell Communications Research, Holmdel, N.J.

QUIET PRINT INVADES OFFICE

Able to mix text and graphics on the same page, nonimpact technologies are likely to supplant noisy impact machines

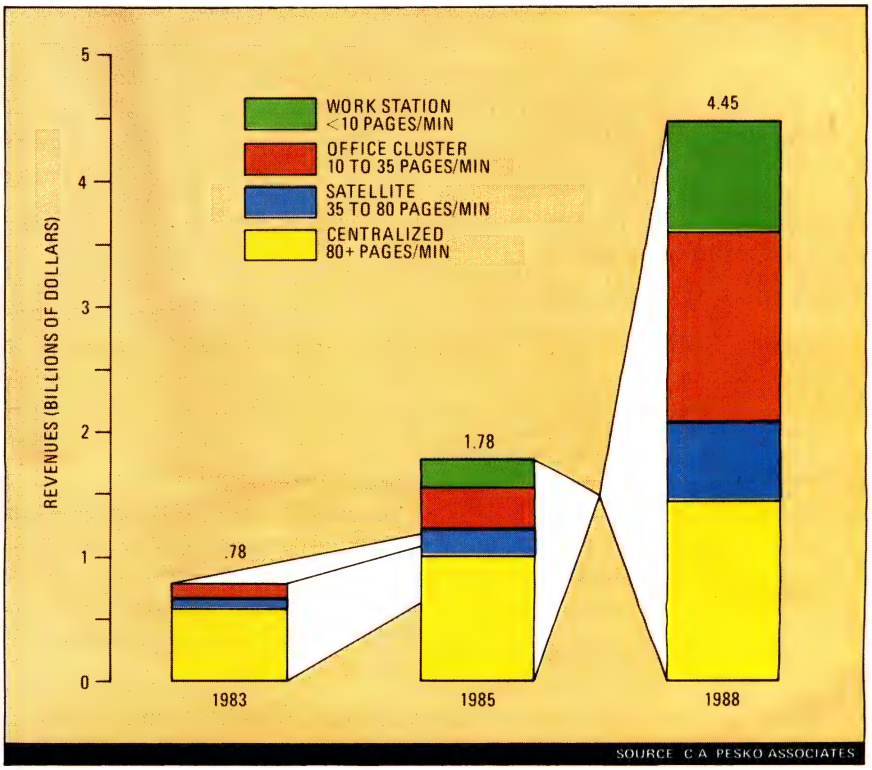
☐ *by Robert Rosenberg*

Savants who a few years ago were predicting a paperless office are probably still composing paeans to electronic progress over the din of daisy-wheel printers. Those impact machines may soon be retired, though not by electronic mail. A new wave of nonimpact print technologies, which can paint text and graphics together on the same page—and do it quietly—is overtaking the clattering old workhorse of the office.

Electrophotographic laser printers, which used to be confined to high-volume data-processing centers, are found doing low- and medium-volume print chores. So, too, are such newcomers as magnetographic, ion-deposition, and certain thermal printers.

The new technology is arriving at the office none too soon. Despite the age of electronic information storage and retrieval, the amount of printing on paper, far from declining, is increasing dramatically. "Industry sources estimate that the total output of American businesses will rise from 2.5 trillion pages last year to more than 4 trillion in 1989. That's enough to cover the state of Illinois—as well as Indiana and Wisconsin—with paper stacked 60 pages high," said Robert V. Adams, president of Xerox Corp.'s System Group, at the first trade show for corporate electronic-publishing systems, in Chicago this past January.

Much of the action is in low-to-medium-volume printing, not the huge runs of a data-processing center. According to Charles A. Pesko Associates Inc., a market-research firm that tracks the nonimpact-printing industry, the market for the new technologies is set to explode. Pesko projects that it will jump from $1.7 billion this year to more than $4.4 billion by 1988 (Fig. 1). The firm thinks the largest growth will take place in the market's low end—work-station printers that produce fewer than 10 pages per minute and office cluster machines that pump out 10 to 35 pages per minute.

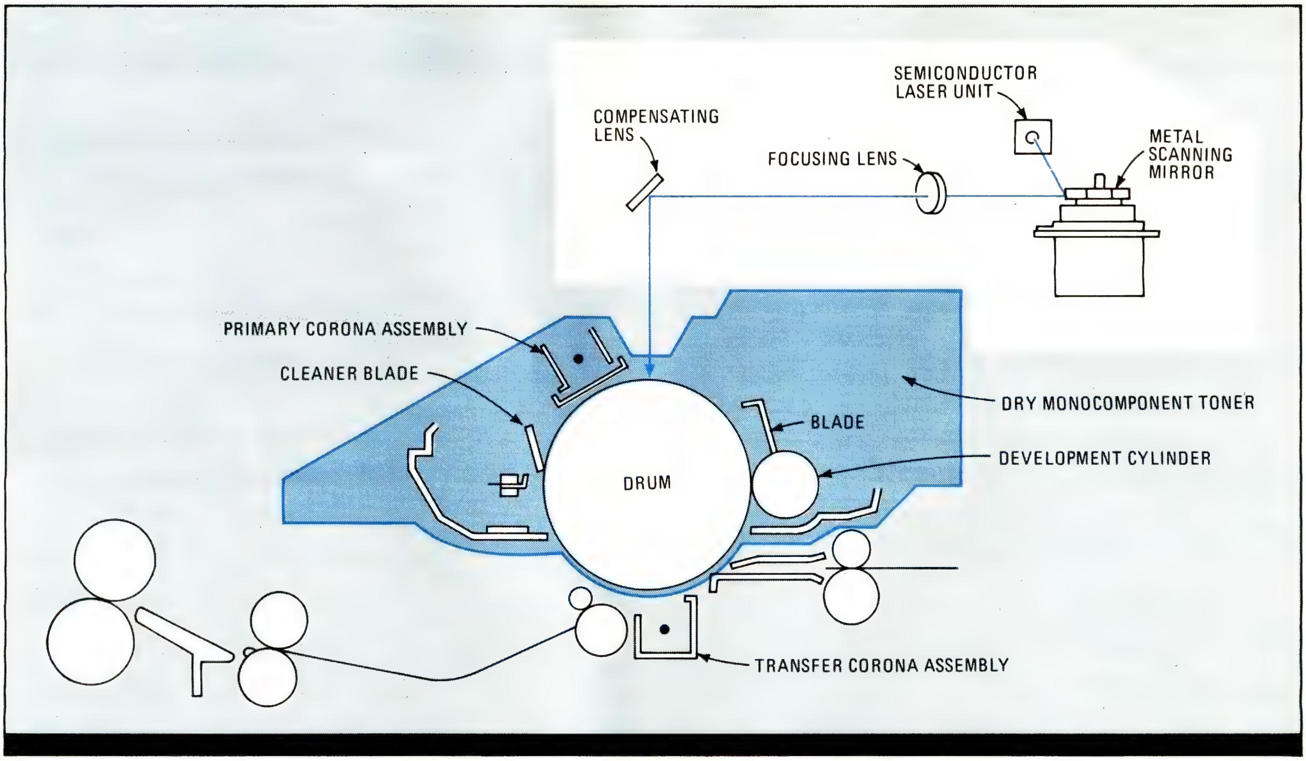


SOURCE: C.A. PESKO ASSOCIATES

1. A mint for print. Market revenues for nonimpact printers are set to explode, says Charles A. Pesko Associates. Though the market has evolved slowly, it should reach $4.5 billion by 1988, with the most growth occurring in the under-35-pages/min class.

Datek Information Services Inc. reads the market in much the same way. Naomi Luft, an analyst tracking printing markets at the firm, says the number of nonimpact units that were shipped between 1983 and 1985 is expected to jump from 5,200 units in 1983 to more than 89,000 in 1985.

The jump in sales of nonimpact printers has resulted



2. Friendly laser. The heart of the Canon LBP-CX electrophotographic laser printer is the user-replaceable cartridge, which contains toner, developer, drum, and the corona assembly. A rugged and inexpensive metal scanning mirror was also crucial to the product's success.

from the spectacular success of Canon USA Inc., whose LBP-CX laser printer is one of the brightest stars in the market for printers turning out under 10 pages/min. The LBP-CX is the engine behind Hewlett-Packard Co.'s LaserJet, Apple Computer Inc.'s LaserWriter, and Imagen Corp.'s 8/300.

"It was a breakthrough machine," says David H. Goodstein, president of Interconsult, a market research firm that follows print technology. Goodstein explains that laser printers such as the $500,000, 120-page/min Xerox 9700 were available for high-volume environments, but at the low (10-page/min) end, the Xerox 2700 was out of reach for most users. It "starts at about $20,000, but with electronics, it turns out to be as much as $40,000." Goodstein says that Canon came up with a highly reliable machine and pared the costs of manufacturing it to the bone.

Electrophotographic printing

Most laser printers are electrophotographic: they use a process, derived from xerography, in which the drum is charged by a beam of laser light. A photoconductive belt or drum—an insulator in the dark—is charged with a layer of positive ions. When a light source strikes the surface, the drum becomes a conductor, and the loosely held ions are dissipated. A rotating mirror deflects the modulated light source across the drum, exposing the background area and leaving a trail of positively charged dots. When a negatively charged toner is spread across the drum's surface, it adheres to the positively charged area. Usually, heat fusing and pressure fix the toner to the paper.

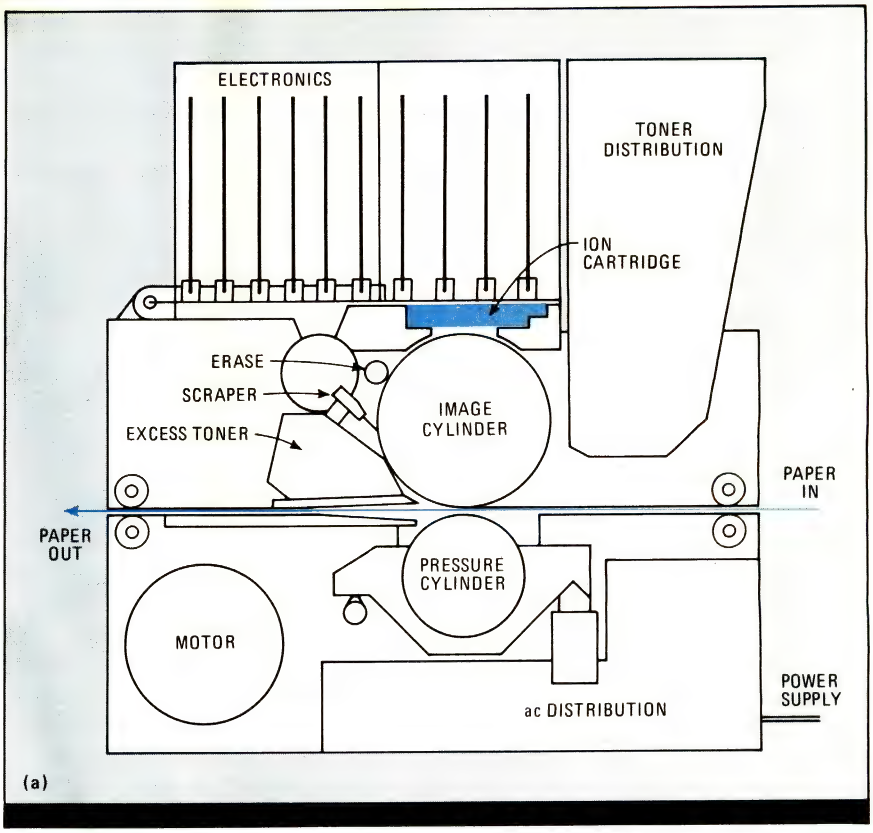
Canon, combining laser optics with a reliable feed and an easily replaceable cartridge from its PC 10/20 desktop copier, played from its strength as a manufacturer of plain-paper copiers. "I remember that when we started in business, people said we'd go bankrupt servicing the LBP-CX systems," chortles Luìs Trabb-Prado, vice president for research and development at Imagen Corp. "But we've had machines that lasted four to five times their expected lifetimes."

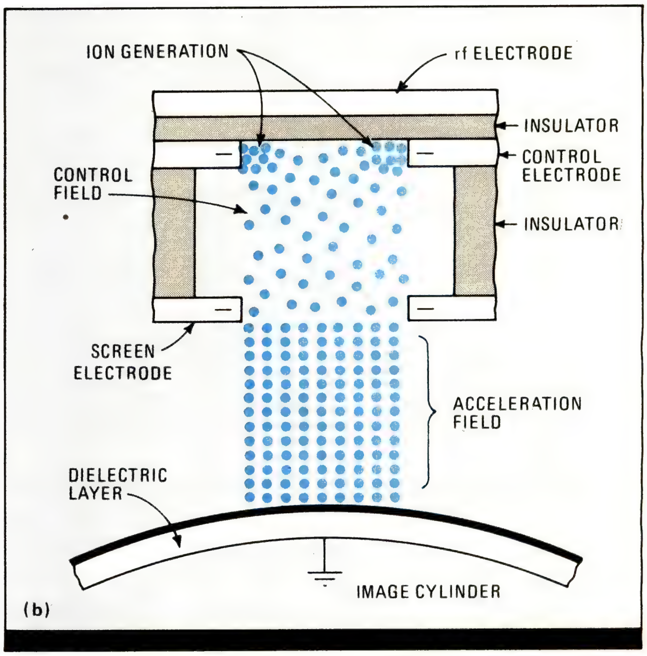
Hiedeo Yamamoto, director of the Laser Beam Printing Division of Canon USA, asserts that putting the dry toner, developer, drum, charging devices, and other parts that need frequent replacement in a disposable cartridge was a big factor in the printer's success (Fig. 2). "Regardless of the type of document being printed, the printer always works at eight pages a minute, and it gives consistent quality because there is no wear," he says. All the parts that might wear out with use are replaced along with the cartridge.

The optics, which are never replaced, are said to be rugged and reliable. The key component is an inexpensive metal scanning mirror used to rasterize the light source. A semiconductor laser pulsing at 1 MHz is picked up by the scanning polygonal metal mirror, then passed through the compensating lens. This lens—which ensures a uniform spot shape by adjusting the differential velocity at the outer and inner portions of the rotating photosensitive drum—passes the pulse to it, achieving a resolution of 300 dots/in. The mirror is the breakthrough, but Canon is releasing no details.

The company is pushing to close deals with original-equipment manufacturers as quickly as possible because Japanese competitors are closing in fast. "These companies saw our success, so they'll be coming into the market too," says Yamamoto. Next spring, Casio Computer Co. plans to deliver a printer that turns out nine pages

3. Pumping ions. Part of the strength of Delphax Systems' ion-deposition printer comes from technology that directly charges the drum, eliminating optical parts and lowering parts counts, and the horizontal paper path, reducing the likelihood of misfeeds (a). To charge the drum (b), radio-frequency lines are excited, causing a corona discharge. The excited ions stay in the control field until printing, when the negative ions are accelerated onto the drum.





per minute and has a resolution of 240 by 240 dots/in. Casio's machine uses liquid-crystal shutters instead of a laser. The shutters, arranged in an array, are composed of short lengths of graded-index optical fibers; these fibers act as small conventional lenses do, passing light to the photosensitive drum.

Suwa Seikosha Co. promises to release a similar product through its production affiliate, Epson Corp., by year's end [*ElectronicsWeek*, Oct. 1, 1984, p. 14]. Konishiroku Konica is also at work on a laser printer: its model LP-3010 has the same resolution as the Canon engine and accepts four different paper sizes. The Konica machine reportedly will crank them out at the rate of 10 pages/min.

For low-end printers, the Japanese strategy is to deliver bare-bones engines to OEMs and let the OEMs develop the controller and font libraries. For example, HP opted for simple daisy-wheel emulation, while Apple bundles 13 fonts in a full range of point sizes and full bit-mapped graphics into its version of the LBP-CX laser printer. "Software for the front end is always expensive, so the Japanese are bringing dumb boxes with a video interface and giving OEMs the opportunity to develop font libraries," says Pesko.

Canon will also have to contend with Xerox Corp., the company that spawned laser-based electrophotographic printers. It plans to take back a slice of the lucrative market for desktop laser printers. Tony N. Domit, a chief engineer at Xerox's printer-manufacturing plant, in El Segundo, Calif., says the company will be announcing a new printer—"designed as a printer, from the ground up." Building a laser printer in this way means that photoreceptors and the laser can be optimized for printing, says Domit, eliminating the compromises that have to be made when laser copier technology is converted to laser printing.

Electrostatic reproduction

Electrostatic printing, a close relative of electrophotography, moves charged ions to the dielectric drum without a light source. Electrostatic reproduction using a moving stylus is well known to computer-aided-design and computer-aided-manufacturing designers, who punch out monstrous E-sized drawings using such familiar names as Versatec and Calcomp plotters. But actually making the ions jump across a gap onto a drum for office printing is a new twist, pioneered in late 1983 by Delphax Systems, in Mississauga, Ontario, Canada.

"Electrophotographic lasing has the biggest base," says Bill Esler, publisher of *In-plant Printer* and several other publications serving the commercial-printer business. "But I think ion deposition seems to be less expensive and more reliable." Part of this reliability stems from the elimination of an optical assembly, always a target for a possible misalignment. Moreover, the machine has fewer moving parts than laser printers. Like the Canon engine, the heart of the Delphax ion-deposition engine is a userremovable ion cartridge mounted above a drum (Fig. 3).

Inside the cartridge are radio-frequency, control, and screen electrodes separated by two insulating layers. Each of 16 rf electrodes, multiplexed with 128 control electrodes, can excite 2,048 intersections across an 8.5-in. swath of the drum. The 2,048 intersections map precisely to the holes of the screen electrode, which acts as a retention and focusing electrode for the ions.

When the rf lines are excited by a 1-MHz voltage burst, a corona discharge occurs at the intersection of the rf and control electrodes. Applying a positive bias charge of 300 V to the control electrode and a negative bias charge of –650 V to the dielectric drum keeps the excited ions in the control field. In order to create the image for printing, the control electrode is biased to –620 V. This in turn accelerates the negative ions out of the screen electrodes and onto the drum.

Simpler design

Another factor contributing to ionography's better reliability is superior drum and toner technology. "We're getting 99.8% of the toner on the drum transferred to the paper," says John R. Rumsey, vice president for research and development engineering at Delphax. "Electrophotographic printers typically transfer about 78% to 80% of the toner." He goes on to explains that the higher transfer ratio means a simpler design: "A simple metal blade cleans our drum. We don't need the complex toner-feedback mechanisms required in electrophotographic printers."

Domit of Xerox agrees. "The photoreceptors we manufacture can be very touchy devices. They are difficult to manufacture, a problem to keep clean, and must be replaced. The photoreceptors for ionography are one step removed from a beer can—they can be much more forgiving than the photoreceptors we employ."

Delphax is currently offering its ionographic printer in two versions: the 2460 engine and a fully configured 60-page/min printer called the S 6000. Designers are hard at work readying new implementations of the basic technology. According to Rumsey, work on an OEM product for Xerox, announced last December, is progressing, and the initial production prototype of a 30-pages/min version, which will be produced in Japan by C. Itoh & Co., is just about finished.

Ion-deposition printers could probably be made to run at speeds faster than those currently on the market, says Rumsey. "It is certainly possible to model cartridges that could print much more rapidly than they do now, so it is not unreasonable to hypothesize a 200- or 300-pages/min machine. The limitations are more mechanical than technological."

Another technology that can write multiple images without a refresh is magnetography. An array of magnetic heads touches a rotating metallic drum, writing a latent image onto its surface. The monocomponent toner—magnetic particles dispersed in a thermoplastic resin—is then attracted to the drum's surface. When paper touches the toned image, heat fusing fixes it.

A desktop magnetographic printer from Ferix Corp., Fremont, Calif., uses a novel thin-film head designed to produce a sharp image boundary. Because the flux pattern is projected through the plane of the field the head creates, it yields a very sharp image at the edge of a magnetic domain. The four-layer head surrounds a 3.5-mm hole (Fig. 4). Unlike traditional ring heads, which have a coil surrounding the pole, the Ferix pole material surrounds magnetic material, which in turn surrounds the coil. The substrate acts as the return path.

The heads are arranged in an 8-by-16 array that steps in a ½-in.-wide path across the drum, yielding an image with a resolution of 240 dots/in. The drum itself comprises a foam core surrounded by a flexible substrate wrapped in an inexpensive iron-coated Mylar surface.

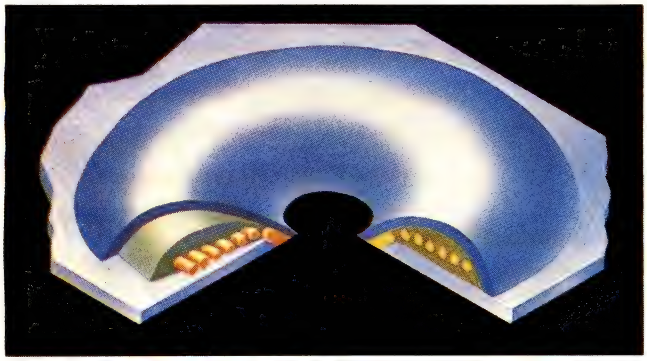
Doug Treuting, product manager for the 10-to-14-pages/min Model 800, says that the planar recording achieved by the inside-out head design eliminates cross-talk at magnetic boundary domains, giving sharp definition at the edge of an image. The contact between head and recording surface means that sophisticated alignments are unnecessary.

Magnetography is also the preferred approach of Cynthia Peripheral Corp., a subsidiary of Bull. Cynthia is producing 50- and 90-pages/min printers aimed at the high-volume printing performed in data centers. Although Cynthia is delivering the same 240-dots/in. resolution as Ferix, it is doing so with 3,360 standard ring heads set in an 8.3-in. array across the drum. "I think Ferix developed the thin film head first, then went out looking for the application. We use a more traditional head technology in a full array," says Tim A. Fondiller, Cynthia's vice president for marketing.

Ink jet

After nearly 25 years of research by such industry heavyweights as IBM Corp. and Siemens AG, ink-jet technology is finally finding its niche. From the tiny Hewlett-Packard drop-on-demand, 1-page/min ThinkJet to a 100,000-lines/min continuous-flow system from Diconix Inc., Dayton, Ohio, ink-jet is clearly finding a range of applications. It is estimated that more than a dozen manufacturers are producing color and monochrome printers using the spray technique.

Both drop-on-demand and continuous-flow implementations spray ink under pressure from a tiny nozzle onto



4. Do-right doughnut. High-quality magnetographic printing requires sharp definitions at the edge of a magnetic domain, an easy chore for the torodial magnetic head from Ferix Corp. The novel head design surrounds the coil (yellow) with magnetic material (green), a top pole (dark blue), and a substrate acting as a return path (light blue). This produces a flux pattern that projects through the plane of the substrate, yielding a sharp magnetic boundary definition.

the page. When a coherent source—for example, a piezoelectric crystal in the print head—excites the ink, the principle of capillary jets makes very regular droplets emerge at the exciting frequency.

In a drop-on-demand setup, the machine propels ink droplets directly out of the reservoir only as they are needed. In a continuous-flow machine, a steady stream of droplets flows out of the nozzle or nozzles and is passed through a deflection field. The deflection field selectively alters the droplets' trajectory, making some hit the page, while others are deflected to a gutter for return to the reservoir. Of the two deflection techniques, multideflection gives greater coverage per nozzle than binary deflection because the electrostatic charge on the drops is modulated to vary the trajectory as they travel to the paper. The binary deflection technique uses a simple on or off state of the electostatic charge to hit the page or deflect the ink to the gutter.

The Diconix 20-pages/min Digit 1 continuous ink-jet printer uses a multiple array of 64 tiny nozzles embedded in a ¼-in. print bar. These openings are barely visible to the naked eye but emit drops at a rate of 75,000/s each, says Richard J. Ernst, an administrator at Diconix's Office Products group. Using a binary scheme, these drops are then deflected to paper or to the gutter. The ink-jet's printer's resolution of 300 dots/in., is comparable to that of laser printers, but the duplex printing (on both sides) available with the Diconix printer cannot be obtained from the current crop of laser-based machines.

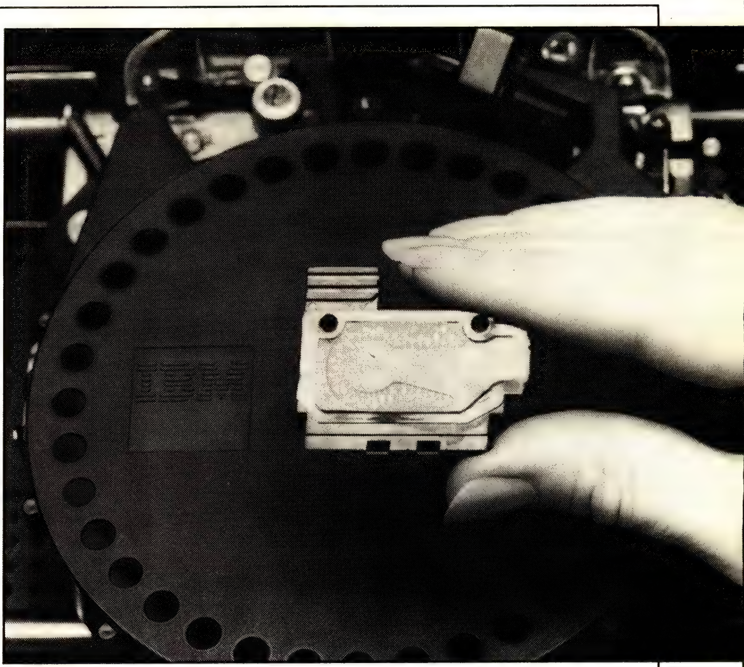
The printer has been in the preproduction stage for eight months, and Ernst says that it will be limited sampling quantities will be ready for shipment by the end of April. However, he will not say when Diconix will deliver a color ink-jet printer. "Obviously, we have the capability to do color, and our plans right now call for the natural progression from single color, to two colors, to full-color printing."

Hot topic

While page-oriented printing technologies, such as electrophotographic techniques, ion deposition, and magnetography, are drawing the most attention, some hot topics remain in character-oriented print technology. "Thermal is a very exciting technology, because it's so simple," explains analyst Pesko. "All the technology is in the print head. Everything else is paper moving and ribbon technology."

One of the firms causing excitement is the Calcomp Group of Sanders Associates Inc., Nashua, N.H.—a mainstay in the plotter and digitizer market. In a major business-strategy shift, Calcomp intends to move out of CAD/CAM to become a force in personal computer peripherals. One of its initial forays into this new area is a multicolored thermal printer. Code-named Bluechip, the product was reportedly using three-colored layered capacitive paper to produce color copy. It has just gone through a major design change—though redesign of the thermal head with eight electrodes/mm is unlikely.

Another interesting development in thermal printing is the announcement of a resistive-ribbon technology pioneered by IBM. The ¼-in.-wide resistive ribbon, which is only about 25 mm thick, consists of four layers—a conductive carbon-loaded polycarbonate, an aluminum return path for current, the resist layer (which lets the ink be released), and a special ink. It is being used in two configurations—a low-speed printer and a new office typewriter.



5. Energetic electrodes. In four-layer resistive-ribbon technology, the tiny stylus forces the ribbon against the paper. When any of the stylus's 40 electrodes is energized, the ribbon's resist layer heats up, releasing small dots of ink to the paper.

An etched tungsten stylus with 40 embedded electrodes touches the resistive layer of the ribbon, forcing it against the paper (Fig. 5). When any of the 40 electrodes is energized, the resistive layer heats up, releasing small dots of ink to the paper. When the ribbon is used in typewriters, a smaller controlled voltage is applied, making the resist sticky, so the ink is captured back onto the ribbon from the page.

"It's just not simple to pull off," says William F. Voit Jr., a manager responsible for this technology at the Lexington, Ky., manufacturing site. He explains that since the stylus is never actually heated, it can be moved rapidly across the paper. "The ribbon itself is in intimate contact with the paper. Most inks smear in comparable situations and can't be rubbed against paper." In fact, the ribbon can handle paper speeds approaching 40 in./s before the transfer film softens and transfers print to the electrodes.

"At the lab, using a special experimental printing robot, we've demonstrated 450-character/s printing with the paper moving at 40 in./s," says Keith S. Pennington, one of the ribbon's developers in the Image-Technology Group at IBM's Yorktown Heights, N.Y., research facility. Although this kind of blinding speed would make the resistive ribbon run faster than most high-end laser printers, Pennington is quick to point out that "this was an idealized model."

Though pumping up speeds is one possibility for the new technology, another wrinkle is giving resistive ribbons color. The ribbon has been used with pigments and dyes, according to Pennington. "The technology is clearly capable of supporting color." ☐

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IC REPLACES DIP SWITCHES

A CMOS circuit, backed by a lithium battery, can be programmed remotely to configure as many as 16 bus lines

☐ *by J. Robert Lineback*

Integrated-circuit technologies have long left a mark in the world by replacing mechanical switching components that are prone to wear out and fizzle with time. But inside digital processing equipment, semiconductors have been much less successful in replacing those little mechanical DIP switches that are widely used to physically set or reconfigure lines of interface ports and communication links.

DIP switches, which come in a wide variety of shapes and designs, are cheap—some cost well under $1. Although inexpensive, these switches can frustrate many nontechnical computer users, who often find they must open up equipment to reconfigure bus lines for newly added peripherals or hardware.

"It has certainly been a tough nut to crack since the very nature of switches is to be nonvolatile and for semiconductors it is not," says Michael Bolan, director of marketing and one of the founders of Dallas Semiconductor Corp. The startup is aiming its expertise in low-power CMOS and batteries-in-a-DIP packaging at replacing DIP switches.

The result is a line of nonvolatile ICs that can be programmed remotely to switch up to 16 lines. In addition, the lithium battery is included inside the 600-mil-wide 24-pin DIP so that settings can be retained for at least a decade without any system power.

Unlike some emerging solid-state switching schemes that store software in nonvolatile EPROMs, the electronic configurator chip contains all of the logic and switching-power transistors needed to configure bus lines. Therefore the 24,000-mil^2 chip frees up host central processors from the overhead software associated with setting and resetting communication lines.

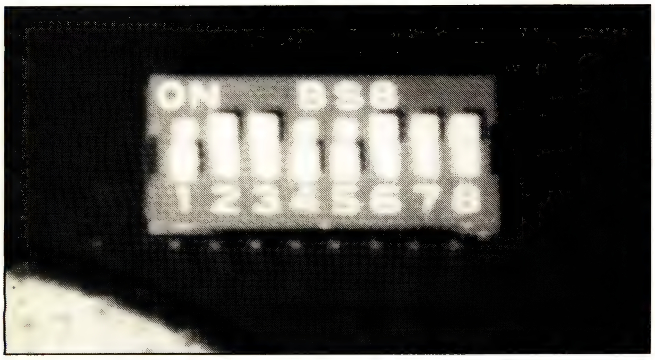
Contained on the CMOS chip are a 128-bit static RAM (9 bytes are spare locations that system designers can use as nonvolatile storage); a 24-bit input shift register; control logic for writing switching settings; 16 solid-state switches; a 16-bit programmable comparator; and power-level sensing logic that turns the on-board memory over to the embedded lithium battery whenever system power is off or falls out of an acceptable range.

Each configurator has one lithium battery cell. The DS1223 circuit also has a three-pin serial port, which loads into the 24-bit shift-register settings of the 16-transistor switches and accesses the SRAM.

"We are not interested in beating out the cost of these little mechanical switches," states Bolan, noting that the electronic configurator is initially priced at $9.90 each in 1,000-piece quantities. "But for most people—maybe 9 out of 10 unsophisticated users—these switches can result in having to call someone. If a service call is needed, we are talking about hundreds of dollars in time, travel, and repair."

In other cases, mechanical switching components can be unreliable when equipment operates in a dirty industrial environment, he adds.

Dallas Semiconductor officials believe the new CMOS configurator opens up new system possibilities, including



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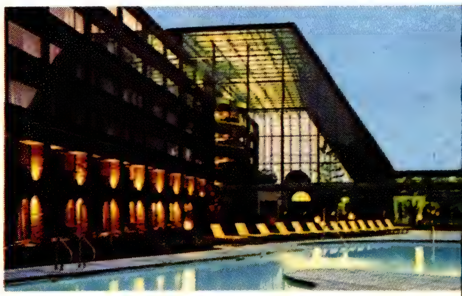

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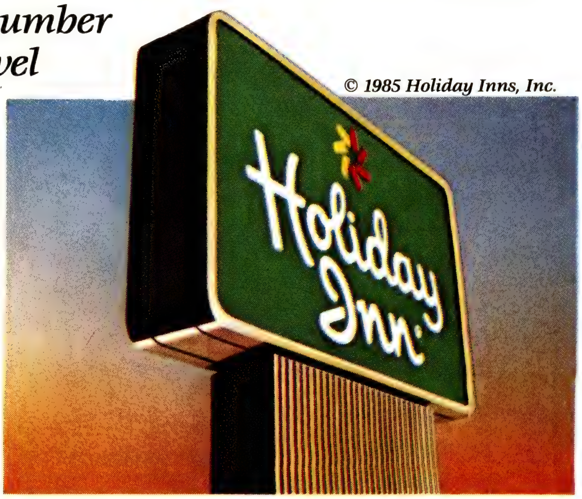

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remote configuration of ports and buses over telephone lines. In addition, menu-driven software could be used to lead first-time users through switch-setting commands. Once completed, the computer would write the settings into the configurator's SRAM.

Users could check settings by solid-state switch with keyboard commands or through service centers with long-distance phone links. Bolan says the remote programmability of switches is an attractive feature in many industrial-systems applications. "We like to think of ourselves as building a remotely controlled switch," he says.

In addition, the chip's 16-bit comparators can be used to address as many as 64,000 configurators. The configurator senses the address by the state of its 16 switching pins, turning them into an identifier. If there is a match, the circuit identifies itself, and the other configurators ignore incoming commands. Each switching pin can be set in a high (5-V) or low (ground) state as well as tied to an adjacent pin, shorting the two together.

The chip has a maximum switching impedance level of 500 Ω and an active power dissipation of 55 mW. Standby current is 10 mW. The chip operates from a 5-V power supply, ±10%. The operating temperature range is 0°C to +70°C. Samples of the electronic configurator are now available from Dallas Semiconductor, which plans to begin volume shipments in May.

The DS1123 electronic configurator is one of several new CMOS circuits being introduced this year as part of the firm's strategy to provide commodity chips that can be customized after fabrication. Late-definition software is loaded into battery-backed RAM, which can retain the chip-tailoring programs for more than 10 years without system power.

Dallas Semiconductor Corp., 4350 Beltwood Pkwy., Dallas, Texas 75234. Phone (214) 450-0400 [Circle reader service number 338]

Simulation tool uses no software models

Eliminating the need for elaborate software models, the Hardware Model Library simulates electronic designs by using actual ICs and pc boards. Using either off-the-shelf, semicustom, or custom ICs, as well as existing pc-board subsystems, the HML lets users of computer-aided-engineering work stations simulate circuits containing complex LSI and VLSI components. Most run at their own rated clock cycle.

A system-wide resource, the HML is part of the design engineer's data base and becomes an extension of the simulation library. It can be shared over networks and is available to multiple concurrent users across an entire work-station network, providing component clocking rates of up to 16 MHz.

With its flexible modular architecture, the HML can accept a variety of part and package types. Three IC-interface boards configured for DIPs, chip carriers, and pin-grid-array packages—the ICIF 64, for up to four 64-pin DIPs; the ICIF 128, for up to two 128-pin DIPs, chip carriers, or pin grid arrays; and the ICIF 256 for a single 256-pin grid array or chip carrier—can be inserted into the HML's backplane. Each system can support any combination of 32 ICs with up to 64 pins, 16 with 128 pins, or 8 with 256 pins.

A 256-channel I/O port is also available for interfacing pc boards or subsystems. Prices for the HML begin at $45,000, and it is available now.

Mentor Graphics Corp., 8500 S.W. Creekside Place, Beaverton, Ore. 97005. Phone (503) 626-7000 [Circle 340]

Graphics work station makes use of two displays

Merging high-performance graphics and superminicomputer power, the GW/10000 SX Graphics Cluster System is a powerful engineering work station with a repertoire of more than 130 graphics commands. With two display monitors—a Dasher D460 alphanumeric data display and a high-resolution (1,280 by 1,024 pixels) 60-Hz noninterlaced graphics display—users can simultaneously view graphics outputs and alphanumeric data and instructions.

Based on the manufacturer's recently announced Eclipse MV/10000 SX superminicomputer, the GW/10000 SX can process up to 3.6 million instructions/s. Available with up to 32 megabytes of memory, the system can support up to four users simultaneously.

The system's performance is due to the implementation of a scientific instruction coprocessor, which performs computer-intensive calculations in parallel with the CPU. The coprocessor, a 15-in. pc board, features 17 gate arrays that execute complex numeric calculations.

At a cost of $283,300, a typical system includes a 354-megabyte disk and dual-mode tape drive. It is available now.

Data General Corp., Technical Products Division, 4400 Computer Dr., Westboro, Mass. 01580. Phone (617) 366-8911 [Circle 341]

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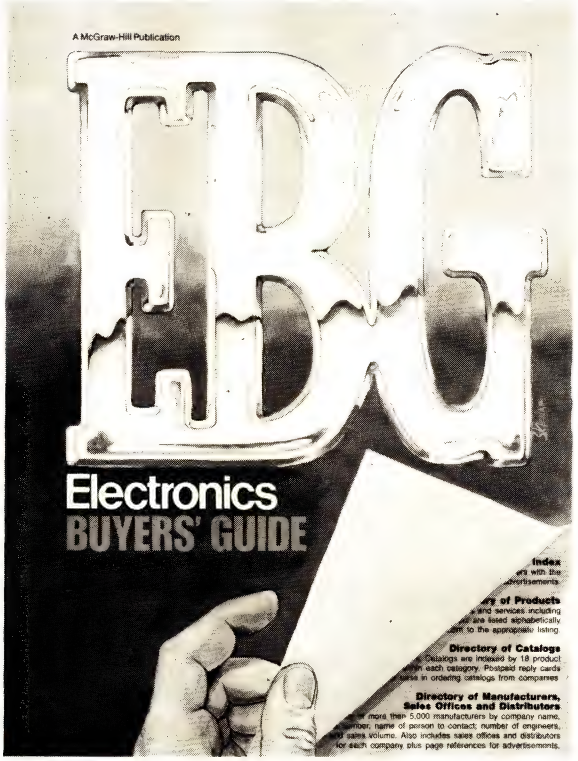
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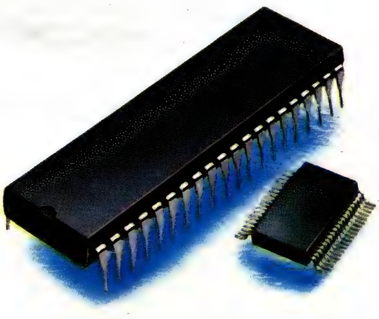

Philips put I²C-bus chips in standard DIL as well as in SO and VSO mini-packages. Comparison shown here is between 40-pin DIL and 40-pin VSO.

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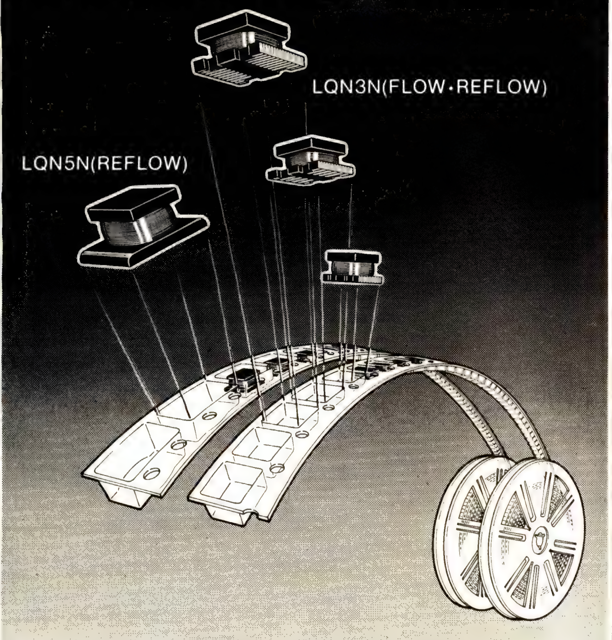

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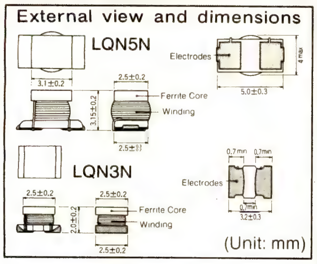

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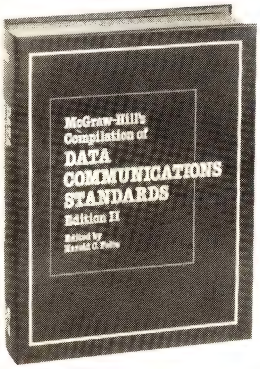

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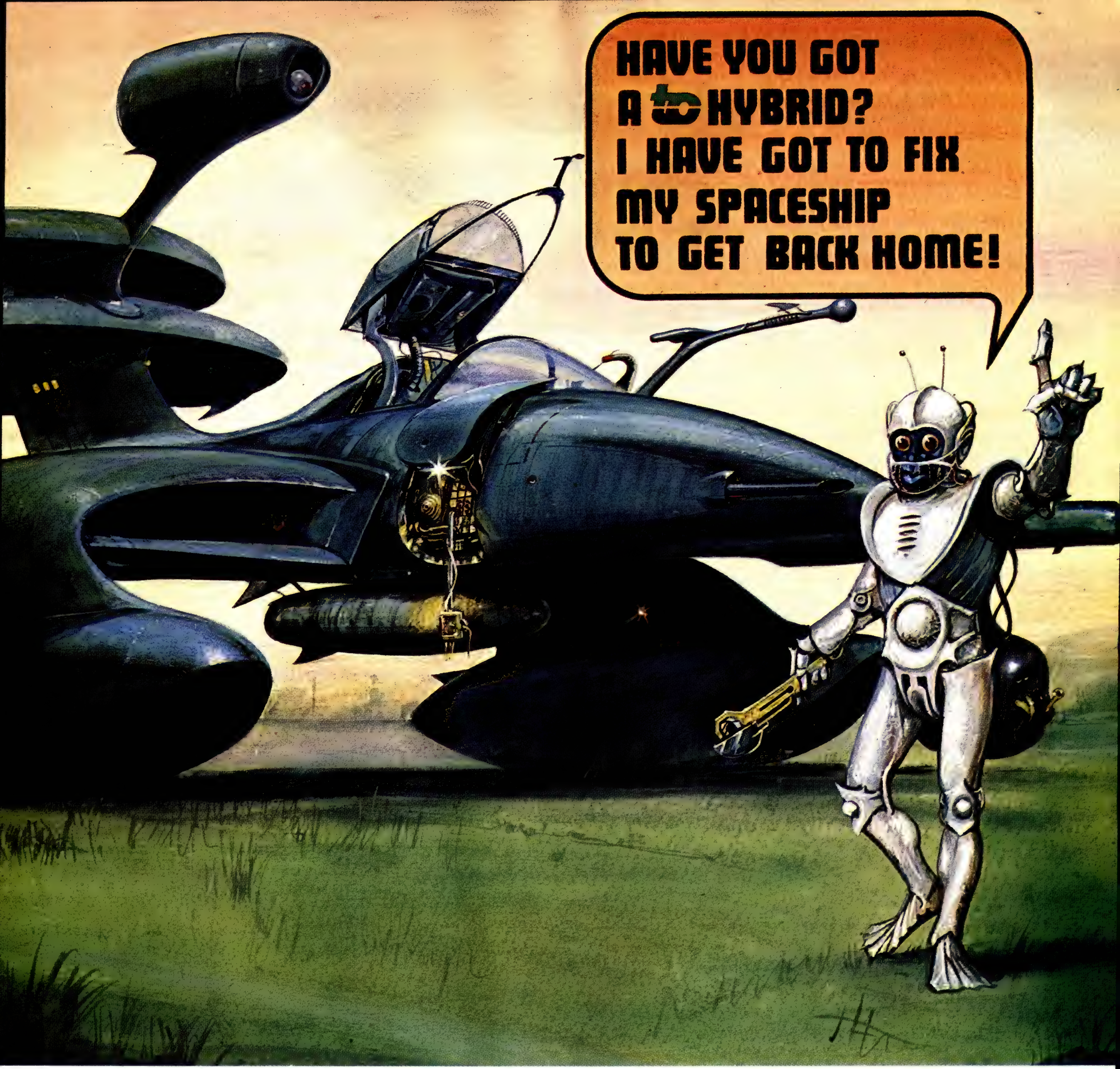
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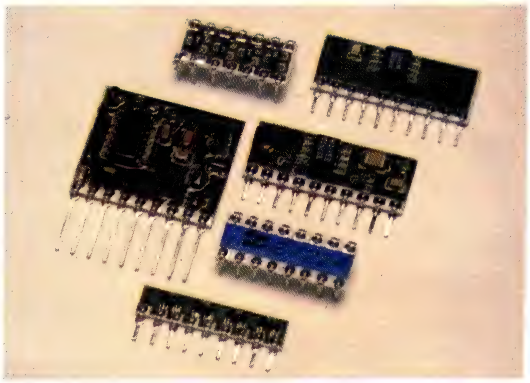

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Based on the compact MicroVAX I system, the VAXstation 500 uses a Tektronics Inc. color video terminal. The VAXstation 500 can stand alone or link with other VAXs and PDP-11s through DECnet.

The base configuration for a VAXstation 500 system consists of a MicroVax I processor with 1 megabyte of memory, dual 400-K byte floppy-disk drives, a 31-megabyte Winchester disk drive, and a graphics subsystem. The subsystem includes a monitor, graphics processor, 256-K bytes of memory, 16-million color palette. Pricing begins at $36,735 for the system, which is available now.

Digital Equipment Corp., Maynard, Mass. 01754 [Circle 342]

IBM PC AT system software available to vendors

Intended for manufacturers of computers compatible with the IBM Corp. Personal Computer AT, Phoenix Software Associates' AT ROM basic input/output system software was developed under strict controls to ensure originality and avoid copyright infringement.

The package, designed for the 80286-based PC AT, is the result of a new development effort and not merely an enhanced version of the software it developed for the PC and PC/XT computers, the company says. The software is now being shipped for beta-site testing, and will be licensed to vendors as part of a package for systems-software compatibility.

Included in the package are a version of the software compatible with the AT's PC-DOS version of the operating system; a full range of utilities; the GW Basic language configured to resemble (but not duplicate) IBM's Basica; and ROM software for an AT-compatible 8042 keyboard controller-chip interface.

The full package is available now to vendors for unlimited licensing at a cost of $440,000. Each part can be purchased separately, however, at the following prices: the AT ROM BIOS, $200,000; the MS-DOS version and the utilities, $60,000 each; the GW Basic version, $100,000; and the 8042 chip support, $20,000.

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Precision Visuals Inc., 6260 Lookout Rd., Boulder, Colo. 80301.
Phone (303) 530-9000 [Circle 344]

Software for IBM PC AT does pc-board artwork

A low-cost tool for creating pc-board artwork, Smartwork software is now available for the IBM Corp. Personal Computer AT.

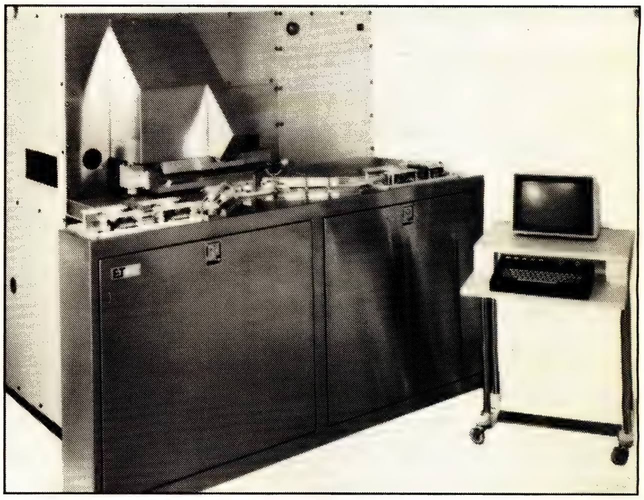
Using the program's quick correction and revision of artwork, designers can produce single- or double-sided boards of up to 10 by 16 in. Layouts can be displayed in either color or black and white. Although its elementary functions are easy to learn, advanced techniques can produce more sophisticated layouts, the company says.

Previously available for the IBM PC and PC/XT, Smartwork can deliver prototype-quality plots on a dot-matrix printer and production-quality work on a pen-and-ink plotter. The system is available for immediate shipment for $895.

Wintek Corp., 1801 South St., Lafayette, Ind. 47904.
Phone (317) 742-8428 [Circle 345]

Plasma-deposition system has 70-wafer/h capability

A low-temperature plasma deposition system, the vacuum load-locked Plasmafab ND5200 can process as many as seventy 4-, 5-, or 6-in. wafers/h, depending on wafer size and process requirements.



The completely automatic cassette-to-cassette system from ET Electrotech can deposit high-quality layers of silicon nitride and silicon dioxide continuously. With a precise temperature-control system maintaining 300°C, the ND5200 can deposit silicon nitride at the rate of 600 Å/min with a typical wafer-to-wafer uniformity of ±1.5% and typical uniformity across the wafer of ±3.5%.

Featuring a low typical-defect density of less than 0.5 cm^2, the system maintains high uniformity by arranging the wafers in a single rotating row. Also included are a variety of safety features and self-diagnostic routines that increase the mechanism's automation.

Pricing begins at $340,000 for the system, which requires 16 to 20 weeks for delivery.

ET Electrotech, 400 Oser Ave., Hauppauge, N.Y. 11788.
Phone (516) 231-3700 [Circle 346]

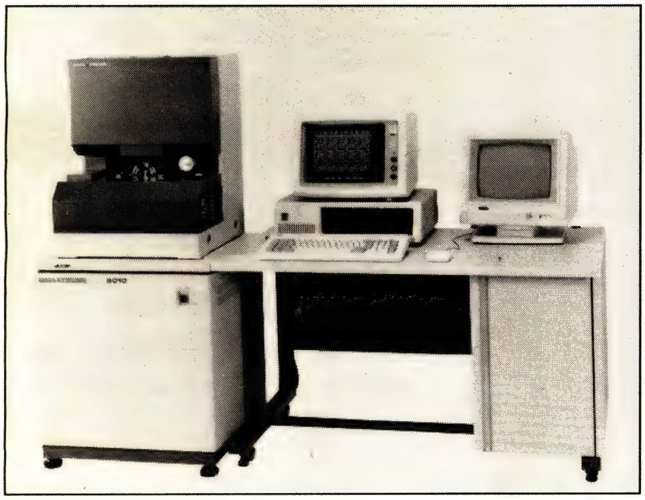
Logic analyzer uses laser to study virtually any IC

Using a nondestructive helium neon laser, a laser IC-logic analyzer, the Data*Probe 2010, is an automated system capable of capturing a logic state at high speed.

The mouse-driven instrument incorporates an IBM Corp. Personal Computer as the main processor, and can test any integrated circuit constructed from any technology. Off-the-shelf, custom, or semicustom designs of logic or memory systems, can all be analyzed by the system, whether fabricated in CMOS, n-MOS, TTL, or any other process.

The analyzer generates timing patterns by measuring an internal IC element's digital state as it interacts with the impinging laser beam. The computer then monitors and processes the photocurrents automatically, providing presentations in either timing patterns or as a series of 1s and 0s.

With the aid a library of functions such as manipulation of acquired data or spatial calibration of a new circuit to a previously stored X-Y coordinate file, the system can match up to 256 pins or channels at up to a 20-MHz analysis capability.



The complete 2010 system, including the laser station and IBM PC, is priced at $150,000. Delivery can be expected 14 weeks from receipt of orders.

Mitsui & Co. (USA) Inc., Semiconductor Test Systems Division, 563 Commerce St., Franklin Lakes, N.J. 07417.
Phone (201) 337-8033 [Circle 347]

Robot transports wafers through automated dicer

Capable of processing up to 75 6-in. wafers concurrently, the System Six/75 automated dicing center features a robotic arm that links the dicing and cleaning modules with the system's wafer-storage bin.

With a single, front-loaded magazine elevator that can accommodate an initial load of up to 75 frame-mounted wafers in magazines, the system offers users a choice of either brush scrubbing or high-pressure deionized-water cleaning, depending on the process requirements of the user.

The system also offers programmable options at every station, including the three-phase air-bearing saw spindle, which can be programmed for from 15,000 to 40,000 rpm in 100-rpm increments. The company's patented MicroEye II solid-state pattern-recognition system automatically aligns wafers prior to dicing, and provides quality checks during and after the operation.

After dicing and cleaning, wafers are dried under a high-pressure air stream instead of a more conventional high-speed spin-drying mechanism. Sawing, cleaning, and magazine load and unload operations all run simultaneously for maximum throughput, while the robotic arm operates in tandem with an automatic wafer buffer to eliminate any dead-time between the sawing and cleaning phases of the operation.

The magazine elevator and the arm are both isolated from the cleaning station to prevent particulate recoating of the wafers after processing.

Pricing for the System Six/75, which is now available, can be obtained on request only.

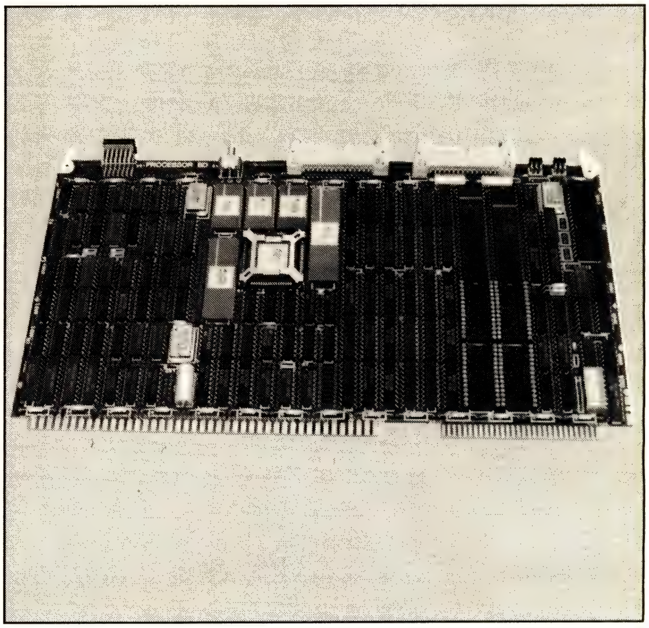
Micro Automation, 48603 Warm Springs Blvd., Fremont, Calif. 94539. Phone (415) 656-8400 [Circle 348]

Multibus gets 32-bit processing power

A 32-bit processor board and the associated memory board provide 32-bit processing for Multibus-based systems, which are traditionally 16-bit systems. The 32032M Multibus board set is based on National Semiconductor Corp.'s 32032 32-bit microprocessor.

The processor board connects directly to the memory over a dedicated 32-bit-wide data path. Thus it is possible for existing I/O controller boards to be used with the higher performance board set within the same backplane. The memory board can provide from 256-K bytes to 4 megabytes of dynamic RAM memory. Error checking and correcting of data is standard.

The set also offers two RS-232-C channels, two programmable timers, monitor and diagnostic firmware, and the 32032-family software. Two of the options to increase the power and flexibility of the board set are a memory-management unit and a floating-point arithmetic unit. The two-board set sells for $3,540 in 100-piece quantities. The set is available now.

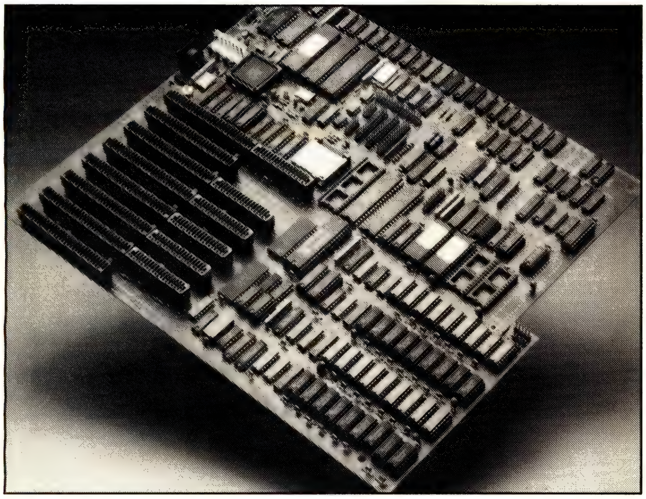


Owl Computers, 640 Crest Dr., Encinitas, Calif. 92024.
Phone (619) 436-4214 [Circle 350]

Single-board computer is compatible with IBM PC AT

Designed for instrumentation and industrial automation, the A-Tease single-board computer is compatible with IBM Corp.'s Personal Computer AT. With 640-K bytes of RAM, the system sells for $1,695.

The product offers 128-K of EPROM socket space, eight IBM-compatible expansion slots, a socket for the 80287 arithmetic coprocessor, one parallel port, and two serial ports selectable as either RS-232-C or RS-422. The board can also be fitted with 1 megabyte of RAM. The

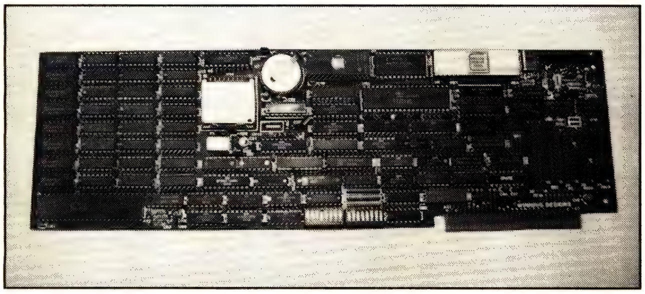


A-Tease will support both the IBM PC and PC AT keyboards.

The product is available for shipping, and the company will provide original-equipment manufacturers with evaluation units and blue line drawings for product development.

Faraday Electronics Inc., 743 Pastoria Ave., Sunnyvale, Calif. 94086. Phone (408) 749-1900 [Circle 351]

Coprocessor for IBM PCs is suited for OEM applications



A coprocessor expansion board called the IQ188 extends the power of the IBM Corp.'s Personal Computer, PC/XT, and PC AT but can also be used independently in original-equipment-manufacturer applications.

The board incorporates a 16-bit Intel Corp. iAPX188 processor running at 8 MHz, 32-K bytes of EPROM, 256-K bytes of RAM (expandable to 1 megabyte), a clock calendar with battery, RS-232-C channels, parallel printer interface, and full Winchester-disk-drive controller for any ST-506 drive.

Board software allows custom applications because user-written programs and device drivers can be downloaded into resident RAM. Software is also provided for spooling to RS-232-C and parallel interfaces, emulating a VT100 terminal, and debugging the iAPX188. In addition, device drivers for clocks, Winchester disk drives, a RAM disk, and other utilities are provided.

A low-power hard disk is also available from the company. The board requires only power and ground from the IBM PCs and thus can be used as single-board computers in OEM products. The basic $1,595 system includes the board, cables, reference manual, and software. Deliveries will begin in April.

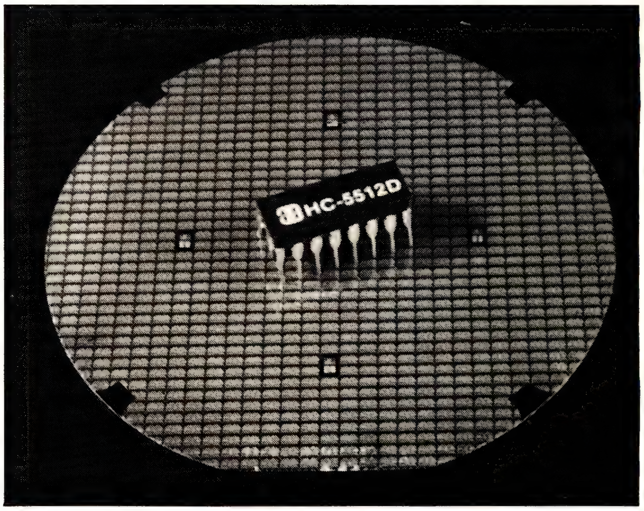
Winning Designs, 2726-46 Ariane Dr., San Diego, Calif. 92117. Phone (619) 483-7556 [Circle 352]

CMOS voiceband filter meets military specifications

A monolithic pulse-code-modulated filter designed for use in military telecommunications applications, the HC-5512D-2 is a CMOS voiceband and antialiasing filter that meets military temperature requirements of –55°C to +125°C.

A second version, the HC-5512D-8, further meets the manufacturer's in-house Dash 8 military standards. The switched-capacitor circuit incorporates both transmit and receive functions on a monolithic CMOS chip.

The circuit features a transmit filter comprised of a fifth-order elliptic low-pass filter in series with a fourth-order Chebyshev high-pass filter to provide a flat response in the 200-to-3,400-Hz band. The circuit's low-pass frequency can be programmed simply by varying the input clock frequency, allowing uses outside the part's intended range.



Packaged in a 16-pin ceramic DIP, the circuit operates from ±5-V supplies; it consumes 50 mW and 0.5 mW in operation and power-down modes, respectively. Currently available, the HC-5512D-2 costs $36 and the HC-5512D-8 costs $44.40 in quantities of 100.

Harris Corp., Melbourne, Fla. 32919.
Phone (305) 727-9100 [[Circle 355]

Family of CMOS arrays offers 440 to 3,900 gates

Complexities ranging from 440 to 3,900 gates are available in the H series family of CMOS gate arrays. Five circuits of different gate complexities provide low-power Schottky TTL performance with 4-ns gate speeds. The

440- and 770-gate models provide 54 I/O lines, the 1,275-gate model provides 80 I/O lines, and the 2,000- and 3,900-gate versions provide 68 I/O pins. The I/Os are configured to support either a TTL or CMOS interface.

The series is fabricated with a 2.8-μm silicon-gate CMOS technology with two levels of metallization. The company guarantees 90% gate utilization through the use of automatic-placement-and-routing software.

Designed for semicustom uses, the circuits offer a library of more than 90 macro functions. Packaging options include chip carriers, pin-grid arrays, and DIPs. Per-gate prices range from 0.6¢ to 2¢, depending on package and volume.

Texas Instruments Inc., Semiconductor Group, Literature Response Center (SC-475), P.O. Box 809066, Dallas, Texas 75380. Phone (800) 232-3200 ext. 700 [Circle 354]

Seven-function multimeter makes 1,300 readings/s

With rates of up to 1,300 readings/s, the HP 3457A 3½-to-6½-digit systems multimeter features seven measurement functions.

Extremely stable readings can be taken at a rate of 1 per second, while speeds over 1,000 readings/s are reached in high-speed signal bursts. The multimeter offers flexible formatting of ASCII, 16-bit, or 32-bit binary data, and a memory that allows the system to function as it transfers the memory's contents to a computer.

A pair of optional scanner cards permits sequential or random access of up to 10 signal channels. The optional general-purpose armature relay-multiplexer assembly has eight two-wire channels and two current/actuator channels, and can switch at a rate of 30 channels/s. The optional high-speed reed-relay multiplexer has 10 two-wire channels and is 10 times faster than the armature relay.

Built-in math routines include statistical functions such as mean and standard deviation, thermocouple and thermistor linearization, pass-fail limit test, and others.

The multimeter is appointed with voltmeter output and external trigger output signals to allow users to synchronize other test instrumentation with the HP 3457A; the IEEE-488 interface bus provides complete programmability. The HP 3457A is priced at $2,800, and the two multiplexer cards cost $450 each. Delivery is within eight weeks from receipt of order.

Hewlett-Packard Co., Inquiries Manager, 1820 Embarcadero Rd., Palo Alto, Calif. 94303 [Circle 356]

Pattern generators deliver precise 50-MHz performance

Running at a 50-MHz (20-ns) rate, a pair of pattern-generator modules extends the performance of the Tektronix Digital Analysis System 9100.

The 91S16 and 91S32 utilize a unique hybrid-circuit technology within the probe tip to reliably deliver 50-MHz performance at the device's pins. This delivers what the company says is the most precise pattern generation ever offered on a logic analyzer. The modules can be used as stand-alone stimulation sources or combined with logic-analysis modules of the DAS 9100 in an integrated test system. The two modules support both TTL and ECL circuitry.

With 16 data channels of pattern generation, two clocks, and two strobes, the 91S16 puts out vectors through a user-written pattern-generation program of up to 1,024 instructions. The 91S32 has 32 data channels, four strobes, and four clocks; it generates stored patterns in sequential order. Up to 2,048 bits per channel may be entered by a user or downloaded from a simulator or host computer, and some or all of the data channels can handle three-state logic under user control.

Up to six 91S32s can be operated simultaneously or, alternatively, five of the modules can be controlled by a single 91S16 to allow a variety of flexible pattern-generation modes, including reloading memory on the fly.

The 91S16 and 91S32 are priced at $6,900 and $10,400, respectively; shipments begin in April.

Tektronix Inc., Logic Analyzer Division, P.O. Box 500, Beaverton, Ore. 97077. Phone (503) 629-1359 [Circle 357]

Raster-system graphics suited to interactive tasks

Designed for military applications that include simulation and training, tactical command and control, and data analysis, the 4500XT raster-system graphics work station features 1,280-by-1,024-pixel resolution and 125-ns/pixel speed. The refresh rate is 60 Hz.

The work station consists of an 68000-based front-end processor, an Am2903-based bit-slice-graphics processor, 128-K bytes of memory (expandable to 2 megabytes), and a 19-in. color or monochrome monitor. A 19-in., 21-slot, expanded rack-mounted card cage is available, and the 4500XT comes in either a rack-mountable or desktop configuration for the office. A high-speed parallel interface for VAX-11 series computers is optional.

Vistagraf, the software that runs on the 4500XT, features hierarchical structure support and structure editing;

subroutines can be called in Fortran. Local pan, zoom, and rotation of images is also supported, as are pixel-plane partitioning and pick capability. With pick capability, the user can choose a structure or primitive and pass the parameters describing the picked object to the host.

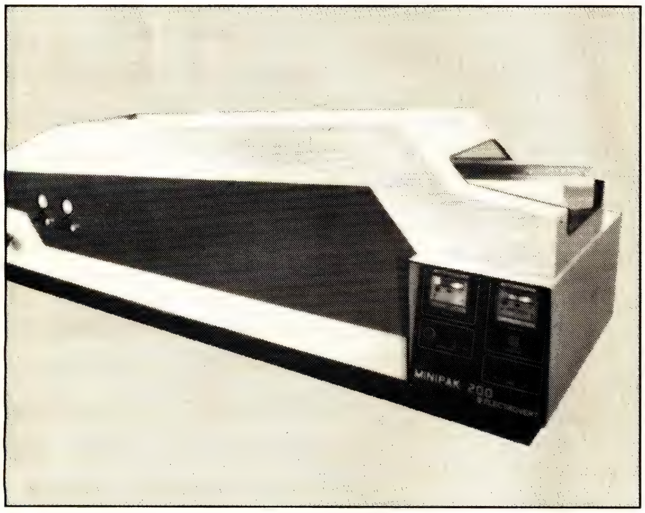
From 16 to 256 colors can simultaneously be displayed, selected from a palette of 4,096. Three types of polygon fill—solid, pattern, and transparent—are available, and the polygons may contain any combination of convex and concave vertices.

The complete 4500XT terminal sells for $33,740, including Vistagraf software, 640-K bytes of graphic-structure storage, keyboard, and a data tablet. Configurations for original-equipment manufacturers start at $15,715, and shipments will begin April 1.

Calcomp Group, Sanders Associates Inc., 2411 W. La Palma Ave.,
Anaheim, Calif. 92801. Phone (714) 821-2142 [Circle 366]

Soldering system maintains temperatures within ±1%

Completely self-contained, the Minipak 200 compact bench-top wave soldering system handles short-run, low-to-medium volume production of pc boards up to 8-in. wide, IC substrates, and micromodules.



The Minipak 200 comes with a solder-temperature controller-indicator that can maintain a preset temperature to ±1% of full scale. A finger-wheel wave-height control for fine control to within ½ in. and a digital central console are also included.

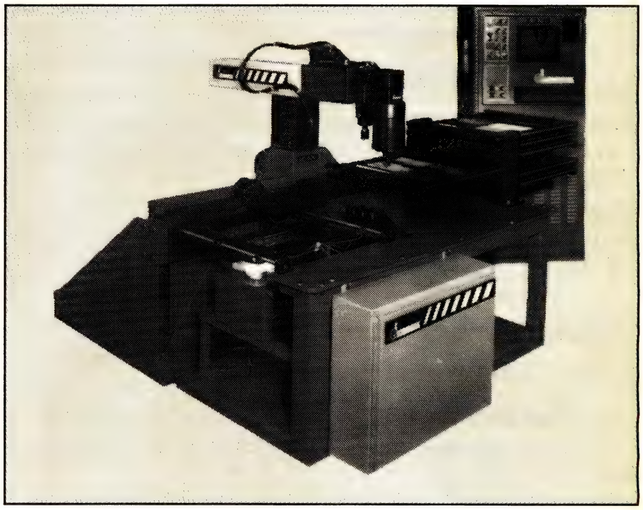
The system includes a foam fluxing station with an exit air knife; a preheating station with a panel-type heater; a 230-lb-capacity stainless-steel solder pot with cartridge-type heaters; and a fixed, inclined conveyor with an idle area at each end. The glass-topped cabinet that encloses the system traps and vents heat and fumes; sliding glass panels provide access to operational areas.

At a price of $7,300, the Minipak 200 takes four weeks for delivery.

Electrovert USA Corp., P.O. Box 458, State Rte. 5 S., Camdenton,
Md. 65020. Phone (314) 346-3341 [Circle 358]

Portable vision system brings labs up to date

Designed for university and corporate laboratories, the Lab Development Package from Automatix is an artificial-vision system that is based on the company's Autovision III computer.



The portable package includes easy-to-use software, the company says, making it well suited to the training laboratory environment. The system runs under Rail, Automatix's own computer language, and interfaces with many robots currently used in labs.

The basic system includes the Autovision III, a keyboard and CRT, two solid-state cameras and lenses, basic lighting and fixturing, and a standard software package. Standard software includes programming utilities and a turnkey menu-driven demonstration. Optional software offered by the company includes gray-scale, stereo vision, and gradient operations.

Available now, the package ranges in price from $35,000 to $50,000, depending on software requirements. The package includes training at the Automatix Customer Training Center. Educational institutions, however, are eligible for a special $20,000 discount package that uses the older Autovision II computer and includes one camera and five software packages. The discount offer expires April 15.

Automatix Inc., 1000 Tech Park Dr., Billerica, Mass. 01821.
Phone (617) 667-7900 [Circle 359]

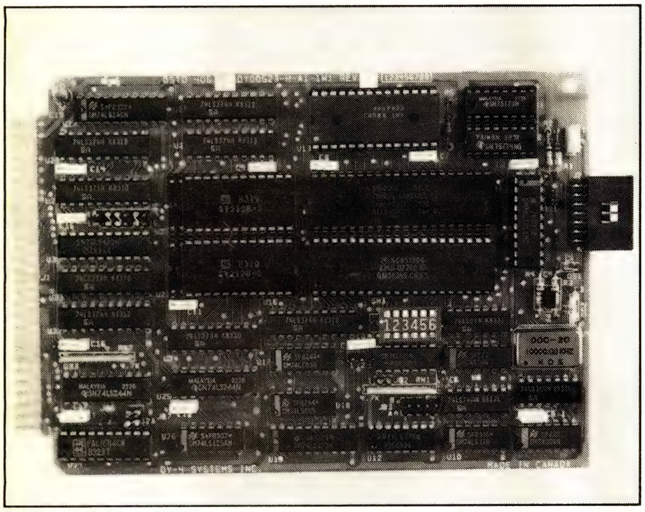
Intelligent serial interface manages up to 64 nodes

Based on the Omninet chip set and compatible with other Omninet transporter modules, the DSTD-406 is an intelligent serial-interface module that accommodates up to 64 nodes at 4,000 ft (with repeaters).

The semibuffered transporter card supports Z80, 8088, and 68008 processors; it also supports the first four layers of the International Organization for Standardization's seven-layer network model (the physical layer, the data-link layer, the network layer, and the transporter layer) and can address a full 1 megabyte.

Designed for high-speed long-distance serial communication, the DSTD-406 Serial Interface Module transporter card is available immediately for $685.

DY-4 Systems Inc., 1475 S. Bascomb Ave., Suite 202, Campbell, Calif. 94008. Phone (408) 377-9822 [Circle 360]



Network duplicates data to provide its own redundancy

With Mimic Master, which duplicates in real time any data written to the network master, redundant processing becomes possible for users of the HiNet local-area network. All the mimicking is done in software that emulates a fault-tolerant mode; it is sometimes referred to as a shadow master.

Mimic Master attaches to the network system in three ways. The user can boot it as Mimic, install it as a replacement for the primary master, or install it as a work station. Mimic-mode operation calls for the Mimic to contain an identical copy of data files, partitions, default settings, and system tables from the master computer. A network of up to 63 stand-alone personal computers or HiNet intelligent work stations can be controlled and supported by the network or the Mimic Master.

Mimic Master is available now for $7,950.

Digital Microsystems Inc., 1755 Embarcadero, Oakland, Calif. 94606. Phone (415) 532-3686 [Circle 361]

Controller card manages 12 motors, solenoids

Combining the functions of several industrial-control cards on one card, the STD 7520 handles up to 12 devices, such as ac or dc motors, relays, solenoids, or solenoid valves. It can monitor up to 11 high-voltage ac or dc components using the TTL I/O lines in combination with external optoisolated I/O modules.

The card also provides analog-to-digital conversion: it will monitor up to eight single-ended or four differential analog inputs and convert them to a 12-bit word with sign. Space is provided for scaling resistors, with which the user may configure the analog input range.

The STD 7520 industrial-control card costs $595 for a single unit. Delivery will be made in four weeks.

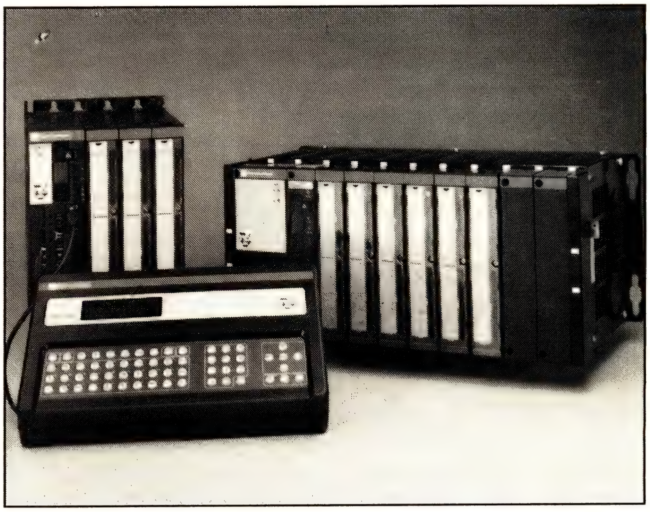
Can-Tron, 440 Junipero Ave., Pacific Grove, Calif. 93950. Phone (408) 649-8041 [Circle 362]

Programmable controllers give choice of languages

Three languages—ladder, mnemonic, and Grafcet, (the new international function-chart language)—run on the TSX-7 series of programmable controllers. Products offered are the TSX-27, with 20, 40, 60, or 80 I/O points, and the TSX-47, with 32 to 256 I/O points. Analog and special-function I/O lines plus peer-to-peer networking on the user-transparent Telway 7 are also offered.

The TSX-7 series is designed for rugged industrial applications, from in-house fabrication of pc boards to computer-controlled system burn-in. The programmable controllers will be available April 2; prices depend on system configuration.

Telemecanique Inc., 2525 S. Clearbrook Dr., Arlington Heights, Ill. 60005. Phone (312) 437-1150 [Circle 363]



System lets IBM PCs run remote industrial modules

A remote data-acquisition system for the IBM Corp. Personal Computer, the Network System Package permits STD-bus I/O modules in dispersed or hostile areas to be controlled from the remote IBM PC. The package includes two network interface cards (one for the IBM PC and one for the STD bus) plus a Z80 CPU2B card with 8-K bytes of on-board static RAM and 16-K bytes of EPROM.

The communications protocol used for the system is implemented on a single very large-scale-integration chip, the WD2840, which uses a token-bus protocol similar to Arnet but which the company says provides higher data throughput and greater noise immunity. The cable inter-

face uses dual twisted-pair cables to reduce crosstalk, and cable lengths of up to 1,000 ft between nodes are permitted without repeaters or modems. Over 10,000 ft of cable can be included in the system.

The interface is also compatible with the IBM Corp. Cabling System, which is the interconnection standard recommended for large installations.

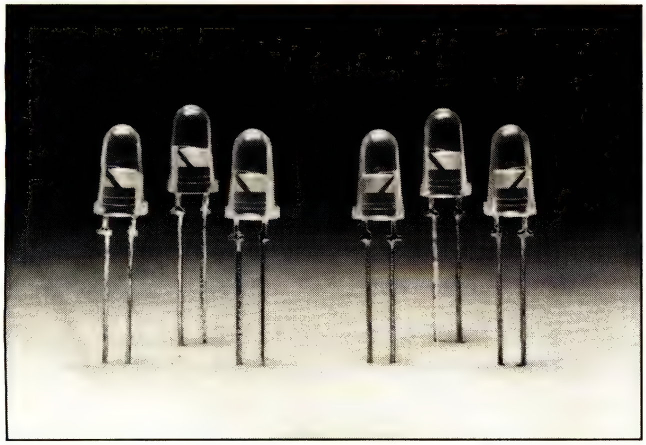
If ordered as a system, the Network Systems Package sells for $1,095; separately, the individual components total $1,635. Delivery takes up to four weeks.

Beal Communications, 11020 Audelia Rd., Suite C101, Dallas, Texas 75243. Phone (214) 340-2044 [Circle 364]

Red LED emits 3,000 mcd, consuming just 20 mA

With a drive current of 20 mA, a red T1¾ LED emits a beam measuring 3,000 millicandela (mcd); at a 1-mA drive current, the LEDs put out 100 mcd. The other lamps in the ID-3000 series have typical beams measuring 220, 1,000, and 2,000 mcd at 20 mA.

Encapsulated in clear, nondiffused packages with narrow viewing angles, the red LEDs use gallium aluminum arsenide die and will not wash out in direct sunlight. In addition to high-intensity red-light emission, the lamps have excellent on/off contrast ratio, fast response time, and are capable of pulse operation; they can be driven directly from CMOS circuits.



Available four weeks after ordering, the LEDs range in price from 40¢ to $3 each in large quantities.

International Devices, 5417 E. La Palma Ave., Anaheim, Calif. 92807. Phone (714) 779-5855 [Circle 373]

Pressure sensor adjusts for temperature on chip

Featuring a silicon shear-stress strain gauge using a single piezoresistive element, the MPX2050 and MPX2051 pressure sensors are temperature compensated on chip to $\pm 1\%$ of full scale from 0° to $+85$°C and to $\pm 2\%$ of full scale over the –40°-to-+125°C temperature range. With a differential pressure range of 0 to 7.3 lb/in.^{2}, deviation from straight-line linearity is less than 40 μV for the MPX2050 and less than 100 μV for the MPX2051.

Because span- and offset-calibration networks are included on the chip, the MPX2050 and MPX2051 are completely interchangeable without recalibration. The networks are individually laser trimmed.

Output in millivolts is directly proportional to the applied differential pressure from 0 to 7.3 lb/in.^{2} and is ratiometrically proportional to the input voltage up to 16 V. Full-scale span is calibrated to 40 ± 1.5 mV with a 10-V dc supply.

The transducers are available as basic elements for custom packaging or they can be purchased with a barbed connection on either the pressure or vacuum sides, or on both. As basic elements, the MPX2050 and the MPX2051 sell for $32 and $27.90, respectively, each in lots of 25 to 99 pieces. Samples are available from stock.

Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, Ariz. 85036 [Circle 374]

MATERIALS ☐ SUPPLIES ☐ ACCESSORIES

Films, papers, and chemicals especially suited to the manufacture of pc boards, as well as other industrial applications, are distributed as the Image One line. Image One includes negative and contact films, direct positive films, negative contact paper, and direct positive paper. Among the processing solutions, Reprodol P developer offers high contrast and maximum density, and is recommended by the manufacturer for fine-line negatives when films must be developed without agitation.

Anitec Image Corp., 1 Paragon Dr., Montvale, N.J. 07645 [Circle reader service number 421]

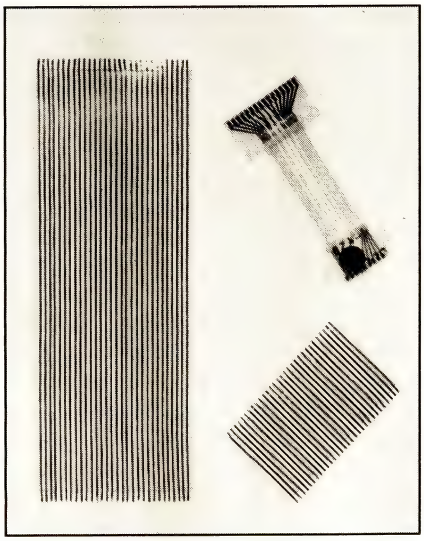
Heat sinks that give bidirectional cooling for leadless chip carriers, the series 5101-3 (patent pending) handle air flow from any direction. Thus 68-lead sockets can be positioned to suit the circuit design without regard to air-flow direction. Models are available in aluminum alloy for Textool and in copper for sockets from Robinson-Nugent and AMP Inc. The design of the series 5101-3 combines the heat sink and lid into a single part, assuring a good match and speeding assembly time. Engineers can request evaluation samples.

Aavid Engineering Inc., 1 Kool Path, P.O. Box 400, Laconia, N.H. 03247.
Phone (603) 524-4443 [Circle 422]

A screen-printable flux for pc boards, Xersin 2010S will protect the clean copper surfaces on a board for at least one year after fabrication, the manufacturer says. Boards that have been coated can be drilled or punched as required, components inserted, and the boards can then be wave- or drag-soldered without any additional application of flux. Xersin-soldered boards meet MIL-P-28809 contamination tests. Xersin 2010 preservative-flux is available as a liquid, a higher-viscosity liquid, and in a formulation that dries in 1 min at 80°C for high-speed automated systems.

Multicore Solders, Cantiague Rock Rd., Westbury, N.Y. 11590.
Phone (516) 334-7997 [Circle 423]

Flexible jumper cables consisting of copper conductors jacketed with a silicone rubber dielectric operate at temperatures from –50°C to +260°C. Designed for use between pc boards, connectors, and subassemblies, these jumpers can be provided with from 1 to 120 discrete conductors, at various pitch widths, conductor sizes from AWG 18 to 32 (size 28 is standard), and twisted or shielded for signal-transmission lines. Conductor ends can be stripped and tinned to any specified length, including differing lengths for staggered termination. Evaluation samples are available.

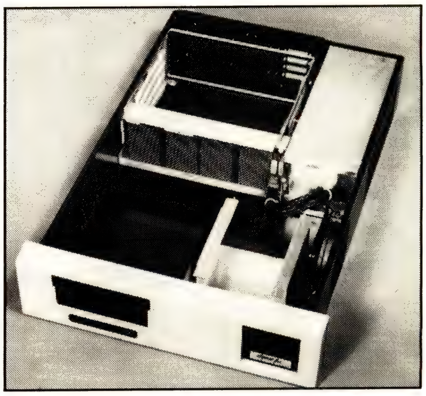


Cicoil Corp., 9100 Independence Ave., Chatsworth, Calif. 91311.
Phone (818) 882-2021 [Circle 426]

Cho-Therm 1671 thermally conductive elastomeric insulators target two objectives in the interface between power semiconductors and heat sinks: enhanced flow of heat from the component to the metal heat sink and electrical isolation of the component. These silicone elastomers are filled with a controlled dispersion of boron nitride particles and reinforced with glass-fiber cloth. They are offered as a replacement for beryllium oxide pads as well as for silicone grease in high-performance applications. The Cho-Therm 1671 series meets MIL-I-45208A standards and is available in standard or custom shapes and sizes.

Chomerics Laminates Inc., 77 Dragon Ct., Woburn, Mass. 01888.
Phone (617) 935-4850 [Circle 424]

An expansion enclosure for Digital Equipment Corp.'s Micro 11 and Micro VAX systems provides a second Q-Bus backplane and card cage with 8 quad (16 dual) slots, a 360-W power supply to support additional controllers, and mounting hardware for 5¼- or 8-in. internal peripherals. A pair of Q-bus expander modules, provide high-speed data paths between the system enclosure and the expansion enclosure. The expansion enclosure can also be used with other DEC Q-bus systems.



Dyna Five Corp., 12040 Western Ave., Garden Grove, Calif. 92641.
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Surface Mountable Components

Now that component placement machines and special soldering systems are available, only one roadblock still exists in the burgeoning SMD field—surface mountable components.

This Special Report will tell what's available, what's missing, what's coming in surface mountable resistors, capacitors, inductors, switches, relays, sockets, connectors and others.

It will include companies such as Philips SMD Technology Service Center, Allen Bradly, Kyocera, Amp, Burndy, Berg, Panasonic, TI, Moto, National Semi, Signetics, AVX, Murata Erie, Mepco-Electra, Rohm, Kemet, Sprague, Harris Semi and others.

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April 8, 1985
Closing for Advertising:
March 18, 1985

ElectronicsWeek
The Magazine of the Worldwide Electronics Industry

Letters

Faulty tests, not chips, says TI

To the editor: In the article "DOD Vexes IC Makers," [*ElectronicsWeek*, Feb. 4, 1985, p. 63], we feel you omitted some important facts about us in the table on page 71.

At the end of August 1984, TI voluntarily stopped shipping chip types that were put through questionable test programs. After we told the Defense Department what we had found, they ordered the services to stop accepting equipment containing any of 6,334 device types, including 1,829 standard SNJ types.

Recently, the DOD okayed all the SNJ devices plus 788 of the SCD types for use in military equipment. This confirms our earlier position that the quality and reliability of the products were not in question—only the details of the test procedures.

Norman P. Neureiter
Vice president, Corporate staff
Texas Instruments Inc.
Dallas, Texas

A ways to grow, says PTT

To the editor: The article "Italians Hope Neighbors Will Buy Their Gear" [*ElectronicsWeek*, Dec. 17, 1984, p. 34] left us puzzled.

Paris's present system, with 6,500 subscribers and a capacity of 10,000, is not yet saturated as the article claims. Also, Radiocom 2000, which goes into service this September, will have a capacity of 200,000 mobile-radio subscribers by 1990. [*Editor's note*—S.A. Matra Radiocommunications also sent a letter to the editor in which they describe Radiocom 2000 as "a modular system fitting every capacity from 500 to 500,000 subscribers."]

PTT, Direction des Radiocommunications avec les Mobiles
Paris, France

Author's reply

Among other sources, I talked to the chief engineer of the PTT's Cellular Radiotelephone delegation as well as a high-level engineer at the PTT's research organization, the CNET. Figures on mobile subscriptions given by these sources varied considerably; the figures I gave were the ones that were most often cited during my research.—Robert T. Gallagher

Sandia's defense

To the editor: This is in reply to your recent article ["Watchdog Raps Sandia," *ElectronicsWeek*, Feb. 4, 1985, p. 15].

The proposed (and approved) radiation-hardened integrated-circuit (RHIC) facility is a $41 million facility. No facilities beyond this funding level have been proposed to the Department of Energy. The $200 million figure quoted by the Inspector General was based on misinterpretation of our long-range plans.

Bob Lee Gregory
Director, Microelectronics
Sandia National Laboratories
Albuquerque, New Mexico

Clearing credits

To the editor: As subjects of the article "Laser Lights the Way to Fast GaAs IC Tests" [*ElectronicsWeek*, Jan. 1, 1985, p. 23], we'd like to clarify the various contributions others have made to this work.

Our technique is closely related to work first done at the University of Rochester by Gerard Mourou and Janis Valdmanis. While employed at the Hewlett-Packard Co., we along with Peter Cross adapted the Rochester technique to the problem of testing an ultra-fast photodiode.

Our new technique required new laser technology. We then collaborated with Jim Kafka and Tom Baer of Spectra-Physics.

David M. Bloom
Associate Professor of Electrical Engineering
Stanford University
Stanford, Calif.

Editor's note: In another letter, Gerard Mourou of the University of Rochester adds the following information: In collaboration with the group of G. Whinnery at Berkeley, we studied the propagation of electrical pulses built on electro-optic materials. Recently, K.P. Cheung, *et al.*, used this property to look at Cerenkov radiation.

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FCC APPROVAL OF ACSSB IS A YES FOR PROGRESS

Federal regulatory agencies are easy targets for criticism. Their decisions very often appear to reflect not so much what is good for the people, whom they ostensibly represent, but the entrenched interests of the industries they are sworn to regulate. That's why the decision of the Federal Communications Commission in the matter of amplitude-compandored single sideband (ACSSB) is as pleasantly surprising as it is welcome.

The ruling [*ElectronicsWeek*, March 11, 1985, p. 13] is sensible, logical, and good for both the industry and its customers. It is also a major victory for the backers of narrowband technologies. The FCC decided to permit operators of land mobile communications to use ACSSB technology to convert their FM assignments to 5-kHz narrowband channels. The commission's old policy served to stunt the development of such systems by effectively discouraging investment in them: the only licenses that it would hand out were temporary or developmental ones.

As we pointed out last fall [*ElectronicsWeek*, Sept. 17, 1984, p. 116], failure by the FCC to deregulate SSB technology would have been followed by demands from the land mobile community for new frequency assigments. That, in turn, would have meant building new equipment to operate at those frequencies, a disservice to the market.

The Electronic Industries Association lined up on the wrong side of the question when the Land Mobile Section of its Telecommunications Group professed itself "unable to quantify potential spectrum savings from ACSSB on the plan proposed by the commission." That view is not surprising, considering the two companies that dominate the Land Mobile Section. Neither Motorola Inc. nor General Electric Co. has made a substantial investment in single-sideband technology such as ACSSB, and both pressured the FCC not to authorize use of ACSSB systems. Thus, if their customers were free to replace FM equipment with more spectrally efficient single-sideband systems, those two firms would find themselves trailing far behind in the market.

Of course, users might not choose to replace existing FM transmitters and radios with ACSSB gear right away. But to the extent that the technology would allow them to create more channels and increase capacity as well as revenues, there will be an incentive to switch. Over the long run, then, the prospects seem bright indeed for manufacturers of ACSSB equipment.

The FCC deserves kudos on two counts. First, it has resisted the pressure to take the easy way out and preserve the status quo. Second, it has implicitly recognized the importance to the market of ACSSB technology and assumed an active role in encouraging its adoption. Furthermore, the FCC ruling has opened a market that previously was being pursued only by two large companies—Motorola and General Electric.

Now, many more companies, particularly those that have made a living by producing FM equipment, will get in the act. And that competition, in turn, should encourage innovation, lead to better and more efficient equipment, and lower prices.

With the free rein it has received from the FCC, single sideband can develop unfettered into an important and legitimate market. And that development should be nothing but encouraging to companies large and small. In this case at least, winners outnumber losers by a very wide margin, and that is what all FCC decisions should be about.

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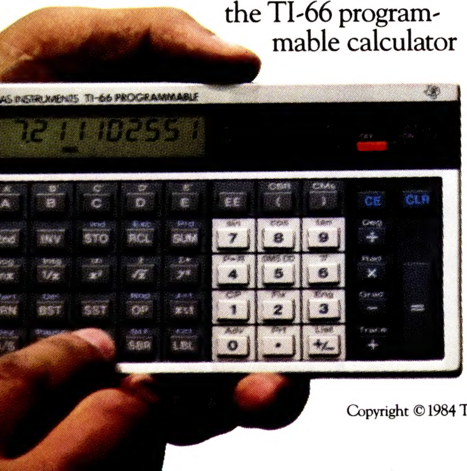

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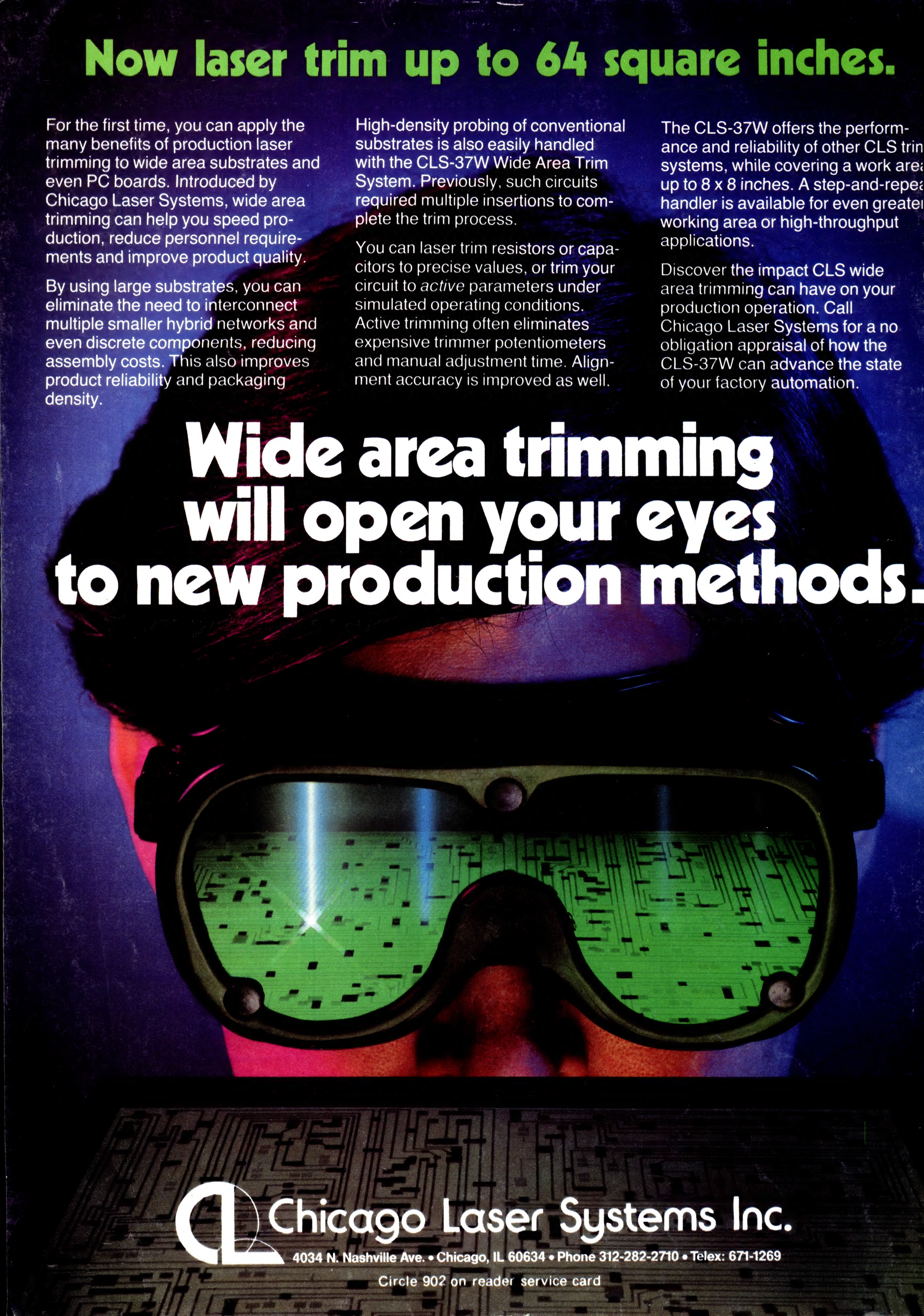

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